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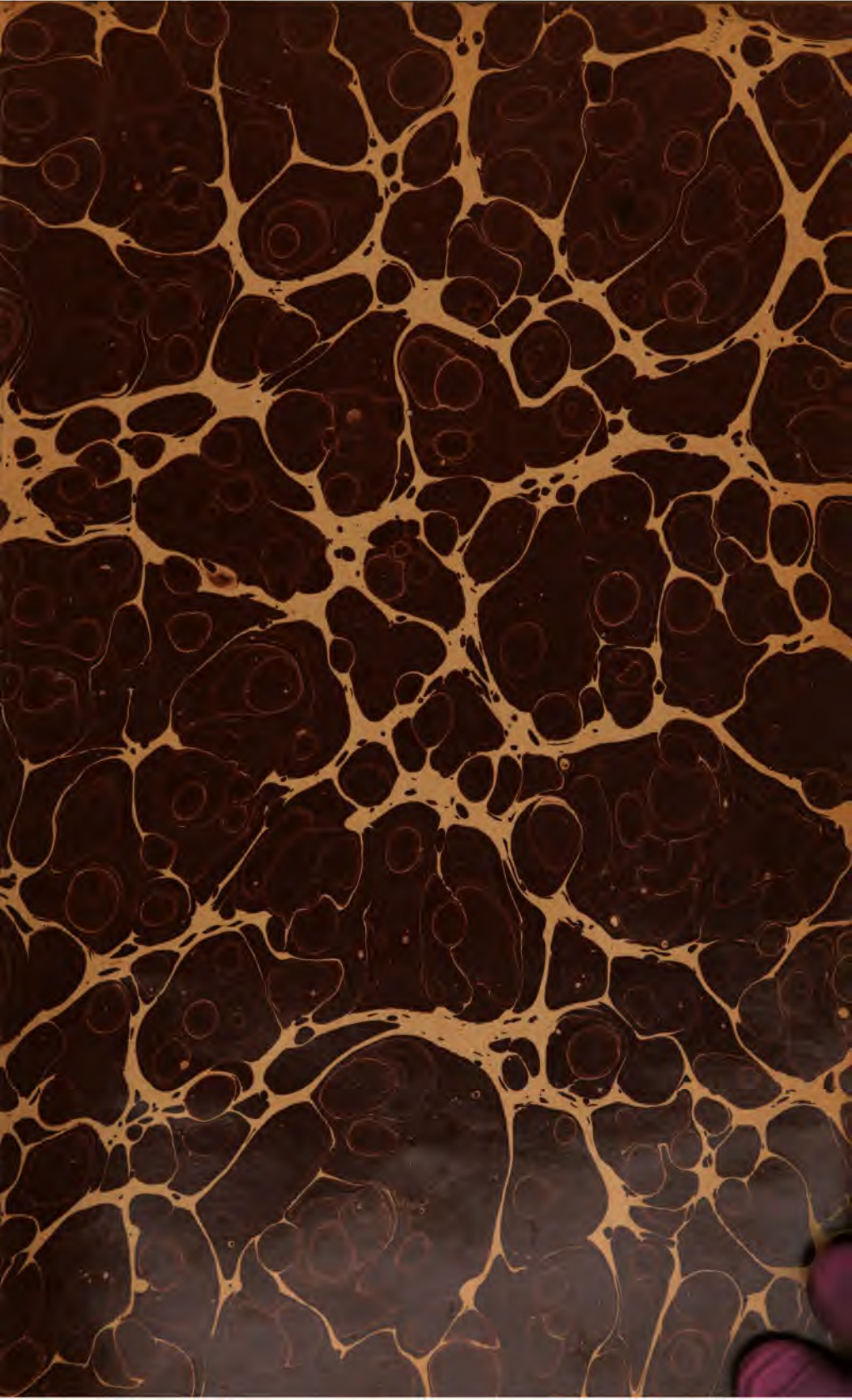
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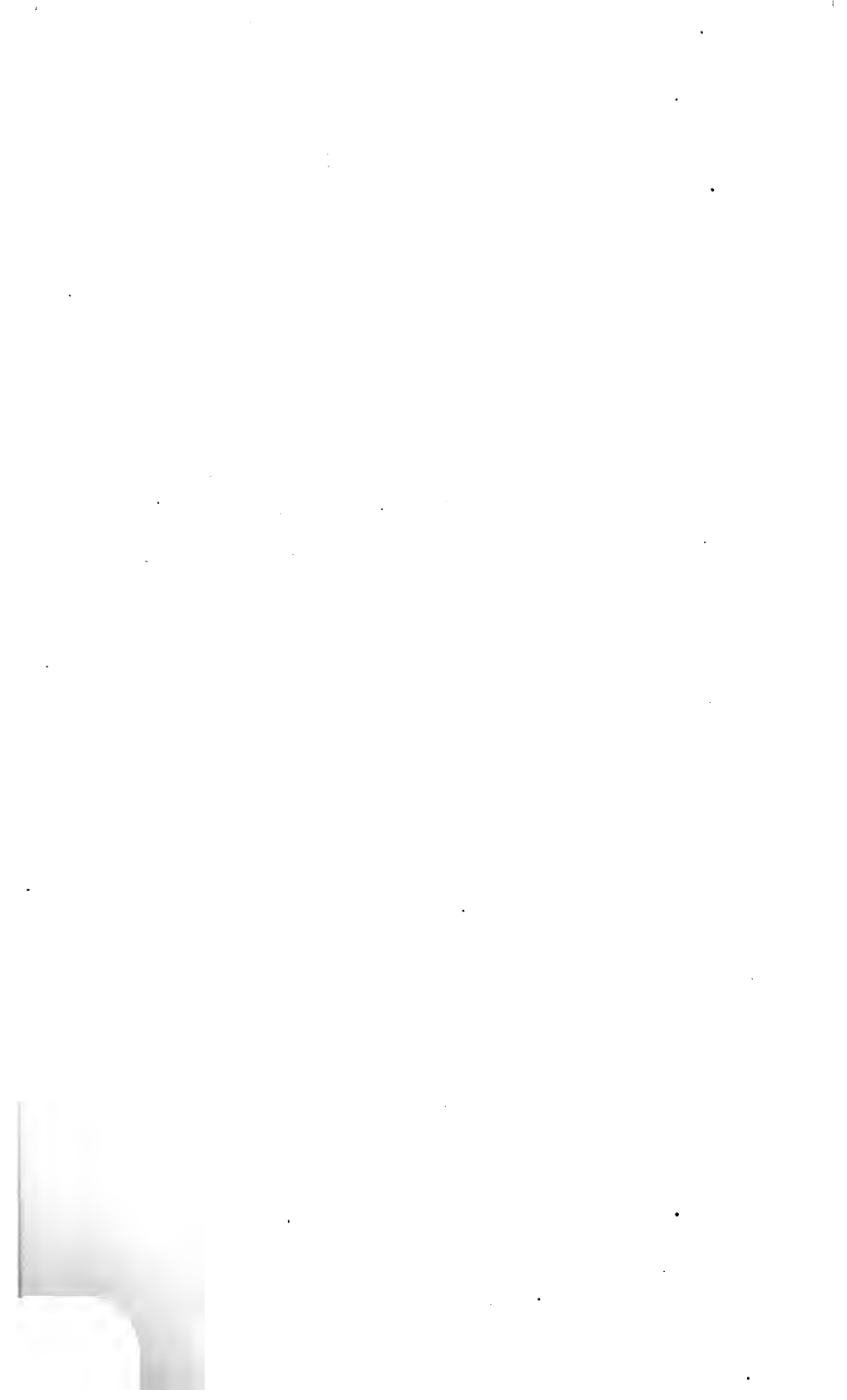


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HEARING

BEFORE

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U. S. Congress House.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE HOUSE OF REPRESENTATIVES

ON THE

ISTHMIAN CANAL



WASHINGTON
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ISTHMIAN CANAL.

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
Tuesday, June 5, 1906.

STATEMENT OF MR. JOHN F. STEVENS, CHIEF ENGINEER OF THE ISTHMIAN CANAL.

The committee convened at 10.30 a. m., Mr. Hepburn in the chair.

Mr. WANGER. Your name is John F. Stevens?

Mr. STEVENS. John F. Stevens; yes, sir.

Mr. WANGER. You are chief engineer of the Isthmian Canal Commission?

Mr. STEVENS. Yes, sir.

Mr. WANGER. You were appointed when?

Mr. STEVENS. June 30, 1905.

Mr. WANGER. When did you go to the Isthmus?

Mr. STEVENS. I sailed on the 20th of July.

Mr. WANGER. And you arrived there about one week later?

Mr. STEVENS. Yes; I arrived there the 26th of July.

Mr. WANGER. And you have been in the performance of your duties ever since that time?

Mr. STEVENS. Yes, sir.

Mr. WANGER. And at the Isthmus until when?

Mr. STEVENS. I was called to Washington for consultation with the Commission, leaving the Isthmus December 12 of last year. I sailed on the return trip January 29, and I was there continuously until I came up on this trip, leaving the Isthmus, I think, on the 17th of May.

Mr. WANGER. When you first went to the Isthmus your attention, I suppose, was fully engrossed with matters of organization and preliminary work?

Mr. STEVENS. Entirely so.

Mr. WANGER. And to what extent have the provisions for housing, feeding, and sanitation progressed?

Mr. STEVENS. Do you mean what proportion to what will finally be required?

Mr. WANGER. I mean what proportion of what is essential to a vigorous prosecution of the work of construction.

Mr. STEVENS. Since the 1st of October the work has progressed very fast so far as quarters and feeding of the men are concerned. The sanitation is not in my department, but, of course, under my daily observation, and it has progressed in a very satisfactory manner, until now the conditions are, to my mind, very good, indeed. We had quite a large accumulation of men on the work—common labor-

ers and skilled laborers that there was not adequate provision for in the way of quarters and feeding. It took some little time to overcome that, owing to the lack of building material; but since the material has arrived freely we have made great progress, until now we are able to take care of the people. There are over 20,000 men on the pay rolls, although that is not the daily working force. But we are able to take care of them all in good shape, both as to quarters and feeding.

Mr. WANGER. The sick as well as the well?

Mr. STEVENS. Oh, yes. In fact, the provisions for taking care of the sick I do not think can be excelled anywhere in the world.

Mr. WANGER. Was any reconstruction of the Panama Railroad necessary?

Mr. STEVENS. Yes, sir; a very large amount of work had to be done on it?

Mr. WANGER. Did you proceed to double track the railroad?

Mr. STEVENS. Yes, sir.

Mr. WAGNER. To what extent has that work progressed?

Mr. STEVENS. We have graded altogether probably about 15 miles and laid tracks on something like 8 or 10 miles that ought to be in service now. I do not know whether it is ready or not, but it was practically so when I left.

Mr. WANGER. What was the purpose in double tracking the railroad?

Mr. STEVENS. To enable us to handle the large tonnage that will be necessary to move in the excavation of the cut.

Mr. WANGER. When you refer to tonnage do you mean the regular business, as well as the work incident to canal construction?

Mr. STEVENS. Yes; the large amount of work incident to the Panama Canal, reckoning the supplies, and the commercial freight. In addition to that there is a large amount of trackage necessary to take care of the waste, the spoil, that must be moved from Culebra cut, there being no other way to dispose of it excepting to take it out and haul it away.

Mr. WANGER. Are you contemplating further double tracking?

Mr. STEVENS. Oh, yes; we are double tracking the most necessary part first—the part where the congestion was.

Mr. WANGER. Is there any congestion of commercial business at present?

Mr. STEVENS. Not the slightest.

Mr. WANGER. What facilities have you provided for landing and shipping material and freight?

Mr. STEVENS. You refer to the ocean terminals, I suppose?

Mr. WANGER. Yes.

Mr. STEVENS. At Colon, the Atlantic terminus, we have a little more than doubled the capacity in floor space of our large dock, the dock that we call No. 4, and we have made heavy repairs on it. In addition to that, we have constructed two new wooden docks at Cristobal, about 1 mile farther up, and have dredged a channel, so that we can take in ships drawing 25 feet. We have dock No. 1 at Colon, which belongs to the Panama Railroad, and which has been used for the handling of coal. That will berth one large ship or two small ones. Then we have dock No. 2, which is used exclusively for foreign line ships, the Hamburg-American Line occupying it almost ex-

clusively, and also for tramp ships. We have eight or ten different regular lines besides the tramps. Then we have the Royal Mail dock, which belongs to them. That is not counted in the general aggregate excepting as affecting the total tonnage of the port of Colon. Then we have dock No. 4, which will dock two large ships. That is the one that I referred to as having had its capacity doubled. Then we have the new dock, No. 12, so called, the first one, as you know, located on the old French canal, and having 25 feet of water. That is a wooden dock, is thoroughly modern, and will take care of two of the largest vessels.

Mr. WANGER. That is around Cristobal Point, on the south side?

Mr. STEVENS. Yes, sir. Then about one-half mile farther up we have another dock that will berth two large ships. In addition to that we have a smaller dock near the same point, that was built previous to the main dock, that will take two small ships, so that gives us 14—that is, it is possible for us to handle 14 ships at a time.

Mr. WANGER. How many ships could you handle when you first arrived there?

Mr. STEVENS. We could handle seven, not including the Royal Mail, and I have not figured that in either. We could handle eight, but one of them, dock No. 4, would be able to take care of only a very small ship.

Mr. WANGER. Then your present docking facilities are about in proportion of 12 to 7?

Mr. STEVENS. Yes; very near double; in fact, so far as utility is concerned, it is double.

Mr. ESCH. Can ships come in and land notwithstanding the various conditions of water and wind?

Mr. STEVENS. They can land at the docks at Cristobal, but there are times when they can not land at the old docks.

Mr. ADAMSON. The purpose, I suppose, is to get the docks as far inland as possible.

Mr. STEVENS. There were two purposes: There was no good docking territory left at Colon, and another reason, and a strong one, to my mind, was that I did not care to spend a great deal of money on terminals located in a foreign country, Colon being in Panama, and the other place, Cristobal, being on the Zone. It seemed to me that the true principle would be to put our money there. In explaining the fact that at times ships can not lay at Colon, it does not necessarily follow that there are storms there of sufficient energy to drive the ships out. But I presume there are storms out in the Caribbean Sea, for without an hour's warning the swell will come in and roll against the docks so that it is dangerous for ships to lie there. During the winter months up here—that is, from the middle of November until the middle of March—it is unsafe for vessels to lie there without keeping steam up. Now they can drop right around into the canal and lay there with perfect safety.

Mr. WANGER. To what depth have you dredged the channel at Cristobal?

Mr. STEVENS. Twenty-seven feet.

Mr. WANGER. What was the depth of the channel prior to the dredging operations?

Mr. STEVENS. Around the extreme end of the point was a quarter of a mile of channel that had anything from 12 to 20 feet.

Mr. TOWNSEND. I understood that there was to be built a breakwater there.

Mr. STEVENS. I suppose you refer to the breakwater from the Colon light-house across to the English light. I think that has been abandoned by all parties.

Mr. ADAMSON. If you moved your base up the canal, then the breakwater would only be serviceable for Colon itself?

Mr. STEVENS. That is all.

Mr. WANGER. What did you find the average cost of dredging to be at this canal entrance?

Mr. STEVENS. About the time I got there Mr. Maltby, who was in charge of the dredging at La Boca, had prepared two of the old French dredges—they are small machines, and in some respects antiquated, but in common with most French machinery they were first class so far as material and workmanship were concerned; and while they had been lying there some time, they were in fair shape. He put them in condition and started one at La Boca, the Pacific end, and one at Cristobal, the Atlantic end. Reckoning the expense of repairs, labor, coal, supplies, and everything, that dredging has cost about—well, not to exceed 8 cents right through.

Mr. WANGER. That is, per cubic yard?

Mr. STEVENS. Yes, sir. They took this material, lifted it up with buckets and dropped it into steam scows, scows that work under their own steam, and it was taken out to sea and dumped.

Mr. WANGER. That does not include any rock dredging?

Mr. STEVENS. Oh, no; simply mud.

You asked about the terminal. I presume you would like to know something about La Boca.

Mr. WANGER. Yes.

Mr. STEVENS. At La Boca the only dock when I arrived there was the old French steel dock, which is 800 feet long and 24 feet wide in floor space and containing two tracks. That was built some years ago; I don't know just when. It is of steel construction, and while it was intended for a good job it is of light construction, in fact the Panama Railroad Company had engines before they received the new ones that could not be run on the dock.

In addition to that dock, they had started another dock, but had suspended work for some reason or another. I went ahead and completed that, and we have it now in service. That dock will berth two of the largest ships that come there from any of the Pacific ports. In addition to that, I have just completed—there were three or four days' work to do when I left—dockage room which will give us another berth between the two, so that now, instead of berthing two ships, we can berth six, because the piece that I put in between the two docks is longer than the ordinary dock, and that, in connection with a little overplus on the steel dock, gives me an additional berth, so that we can handle five ships. And that also largely increases the storage.

Mr. WANGER. Have you strengthened the old dock?

Mr. STEVENS. It is not yet necessary.

Mr. WANGER. Do you contemplate doing it?

Mr. STEVENS. I plan doing it, and I have authority from the Commission to do so.

Mr. RYAN. Is the new dock of steel construction?

Mr. STEVENS. Yes, sir; but I have been waiting upon the decision of the much-talked-of question of the type of canal.

Mr. TOWNSEND. What difference would that make so far as the docks are concerned?

Mr. STEVENS. So far as either of the plans that are under consideration are concerned, sea level or the lock type, and so far as the facilities at the other end, the La Boca end, are concerned, the terminals of the Panama Railroad will be destroyed, including the docks.

Mr. ADAMSON. Can you efficiently and profitably work your force until the next session of Congress without a determination of the type of canal?

Mr. STEVENS. No, sir.

Mr. ADAMSON. Then you have made such progress that you will have to have that question determined before next December?

Mr. STEVENS. Yes, sir. There was a very large amount of work necessary before we could do intelligent and economical work in taking out the material in Culebra cut, owing to the necessity for the shaping up of the cut, getting in the tracks, and, in addition, getting in the quarters. But one of the principal troubles has been the lack of equipment. When I arrived there, on the 26th of July, I think there had been ordered 24 engines for the Panama Railroad, all of which they needed badly. Nothing whatever had been received in the shape of new motive power for Culebra cut proper. There had been ordered 300 small dump cars, which we have just received and put in service; and owing to the lack of equipment on the railroad I have had to use a good many on the railroad proper for handling coal and brick and things like that.

Mr. TOWNSEND. The old French dump cars were not sufficient?

Mr. STEVENS. Oh, no.

Mr. ADAMSON. If you should adopt the sea-level plan, would you have to have the cut wider at Culebra?

Mr. STEVENS. Oh, yes.

Mr. ADAMSON. And that is one feature?

Mr. STEVENS. That is one feature.

Now, talking about equipment, I arrived there on the 26th of July, I commenced ordering equipment for the Isthmus on the 29th of August, and I have kept on up to the present time. Among the first orders that I made to be filled quickly was one for 120 modern engines. Those are commencing to arrive now. There were 35 at Colon when I left there, and they expected to get the last of the 35 out last Saturday. There were 25 more that either had left or would sail from New York in a day or two. Of course it takes some few days to get them out and at work. Then I ordered 800 large flat cars for handling material. Up to the time I left we had received about 80. For the next two or three months I will have equipment enough at work, but I could not have it before. As I told the Senate committee last winter, if I had all the men and all the money in the world I could not do the work until I received the equipment.

Mr. ADAMSON. Will you not handle the spoil a little differently if one type of canal is constructed than you would if the other was constructed?

Mr. STEVENS. If one type of canal is built we can handle spoil at some places better than others.

Mr. ADAMSON. If you have to build dams you can use some of the spoil in that work, and will know it in advance; and I suppose that it can be used to widen the tracks of the railroad.

Mr. STEVENS. Of course I am using some of the material that I have been taking out on the railroad—double tracking.

Mr. TOWNSEND. Did I understand you to say that if a sea-level canal is decided upon that all the dockage at La Boca will be useless?

Mr. STEVENS. Yes, sir; for this reason, that the line of both canals as now laid out crosses the spur which runs down to the La Boca terminal.

Mr. TOWNSEND. Why were those docks put in there, then?

Mr. MANN. I suppose you are referring to the majority and the minority report of the Commission?

Mr. STEVENS. Exactly; yes, sir.

Mr. MANN. And not to any other possible plan?

Mr. STEVENS. The new dock was built or nearly completed before either report was made. You see these terminals were all right providing we should take the same alignment of canal that the French intended to use, which, to confess the truth, I never supposed would be changed.

Mr. WANGER. Then all of this work that you have done at the La Boca terminal will be available providing the French alignment is maintained?

Mr. STEVENS. Exactly.

Mr. WANGER. Is that alignment, in your judgment, practically as good as either of the alignments that have been suggested by the Board of Consulting Engineers?

Mr. STEVENS. Why, I have never seen any very great advantage in either the minority or the majority reports in changing the alignment at that end.

Mr. WANGER. The French alignment had a little greater curvature.

Mr. STEVENS. A little more curvature, a trifle longer, I presume three or four hundred feet.

Mr. WANGER. What depth of water do you have at the La Boca piers at mean tide?

Mr. STEVENS. We have less than 18 feet at low tide, which would be about 28 feet at medium tide.

Mr. WANGER. That will be nearly 40 feet at high tide.

Mr. STEVENS. Yes, sir. As to the extreme difference, we have a record of a tide in March of this year of 23 feet. That would be 20 plus 18, or, say, 38 or 40 feet. That would be the extreme.

Mr. WANGER. And it varies ordinarily from about 17 to 20 feet.

Mr. STEVENS. Yes, sir.

Mr. WANGER. Or 15 to 20 feet.

Mr. TOWNSEND. You did not finish your answer as to the advantages that the terminal which you desire to construct would have over that reported upon by either the majority or the minority committee. I think you said that the French had done something.

Mr. STEVENS. The excavations that the French made for the first 3 or 4 miles from the sea inland laid west of the Panama Railroad all the way and west of the dock. It is a trifle longer and has a little more curvature than would occur under either the majority or the minority report.

Mr. ADAMSON. In what way do those reports deal with the canal in crossing that saddle between the two hills?

Mr. STEVENS. That saddle between the two hills is about 15 feet above tide. Only one plan contemplates going between the hills. The minority report contemplates going on the outside.

Mr. ADAMSON. I wanted to ask you if the excavation in the cut has gone down deep enough to be anywhere near the level contemplated if you build a lock canal.

Mr. STEVENS. No, sir. It has gone down about 120 feet in the lowest point.

Mr. ADAMSON. Would it take you the balance of the year to get through that?

Mr. STEVENS. It will take several years; but you would not work it that way. You would not start in at one point. You see the cut is nearly 7 miles long.

Mr. ADAMSON. You do not want to confine your force to that place any longer.

Mr. STEVENS. Oh, no. When you speak about there being 100 or 160 or 300 feet of cut, that is altogether misleading. If you will let me have the map I will explain how that is. [Explaining on map.]

Mr. ADAMSON. I understood that you had cut out 150 feet.

Mr. STEVENS. The original high point was over 300 feet—330 feet. Now, if we go down 40 feet below mean sea level, there [indicating] would be the bottom of the sea level; in other words, we would have about a 205-foot cut on the extreme center line over the bottom of the sea level. [Explaining on map.]

Mr. KENNEDY. I suppose this cut is through rock?

Mr. STEVENS. Yes; in rock of different degrees of density.

Mr. ADAMSON. Is most of that volcanic rock?

Mr. STEVENS. I think so. I think the principal part of the Culebra Cut is sedimentary; that is, formed by the action of water, thrown up, and heated at different degrees of temperature.

Mr. RYAN. When we were down there we saw more than 200 locomotives, and some 40 of them were of Rogers make. Have you been able to utilize them?

Mr. STEVENS. I have utilized all of the Rogers engines.

Mr. WANGER. I would suggest that we would make better progress if we confined our examinations as we go along to particular subjects. We have had up the matter of terminals, and it would seem to me that it would be well to complete that before going to some other problem.

Mr. STEVENS. I would like to say one thing further before we leave the subject of terminals. In my judgment, it will be necessary to construct another dock at Cristobal, for the reason that the old docks, with the exception of No. 4, which is good for two or three years, are on their last legs. Dock No. 1 and Dock No. 2 are not only very inconvenient and tremendously expensive to handle freight from, but they must be entirely rebuilt within the next couple of years. As I said before, they are up in the open roadstead and on Panama territory, not the territory of the United States. It would be cheaper to build another dock up on the canal adjoining the present new ones than to keep up the old, antiquated docks. It will not cost any more to build a new dock, and then we will have something that we can use to do business upon.

Mr. WANGER. Then you think it would be better to build a new dock at the canal entrance rather than to repair the old one.

Mr. STEVENS. We have put in large yards, shops, and other plants of that kind at Cristobal, into which we are just moving now. Consequently, the expense of handling our freight is decreased by having the docks right alongside the yards. At Colon there has been in the past no well-digested plan of a yard for handling freight.

Mr. WANGER. Then, it relieves your railroad terminals considerably to have the docks further along the canal way?

Mr. STEVENS. Oh, yes.

Mr. WANGER. And the new docks are something like a mile, at least, southeast of the old docks, are they not?

Mr. STEVENS. Yes; right in here [indicating on map].

Mr. WANGER. Those that are there are about a half a mile southeast of the Cristobal point?

Mr. STEVENS. The first one is not over four or five hundred feet from the point.

Mr. WANGER. Do you think it would be advisable to build another dock half a mile or so farther on southeastward, and that that will relieve your railway terminals greatly?

Mr. STEVENS. Oh, yes.

Mr. WANGER. What has been done toward the sanitation of Colon?

Mr. STEVENS. We have filled probably about 50 per cent of the streets, brought them up to the established grade so as to give drainage; and we have cut a drainage canal clear across the island from one end to the other.

Mr. WANGER. Please indicate on the map where that drainage canal is?

(Mr. Stevens indicates on the map the location of the drainage canal.)

Mr. WANGER. The canal parallels the railroad track?

Mr. STEVENS. Yes; about three blocks back.

Mr. WANGER. Does the water flow freely?

Mr. STEVENS. Yes, sir; it has been 100 per cent more of a success than I dreamed of. The water used to stand for days after the heavy rains around under the houses. Now, inside of six or eight hours the water runs off and goes out to sea. In addition to that, we completed, some time in February, the big supply main from the reservoir which we are building back of Mount Hope down to the town. Since that time we have completed distributing mains through the streets of Colon. All that remains to complete the water plant of Colon is to make the house connections, which they are making now (that, of course, is a private matter), and to finish the permanent reservoir back of Mount Hope.

I would like to explain something in relation to the Colon water supply. I have heard a few remarks made about it in which I have not been referred to in complimentary terms. I found last year, when I got there, that some work had been done toward building a very large reservoir back of Mount Hope, in here [indicating on map].

Mr. WANGER. About 2 miles south of Monkey Hill?

Mr. STEVENS. Yes. They had planned to build a large reservoir to hold about eight or nine hundred million gallons.

Mr. WANGER. What is the quality of the water?

Mr. STEVENS. It is fine water—surface water, rain water. The basin is not inhabited, there are absolutely no inhabitants in it at all. A part of the site of the reservoir had been cleared, but no other work had been done. Since then I have been working on the dam, and have laid the mains. Of course we could not get it done in time for the dry season, so we built a small reservoir which under ordinary circumstances would have carried us through the dry season temporarily, but it did not prove to be an ample supply. So just before the water gave out we did what has been done for the last fifty years, hauled water by the water train; and the only difference to the people of Colon was that in one case the water came in the pipe, and in the other it came in the cars.

Mr. WANGER. The charge has been made that the main pipe from the reservoir broke and that then salt water was pumped from the marsh to the main.

Mr. STEVENS. There is no truth in that, not the slightest. I am very glad you mentioned that, for I have never had a chance to explain that. At the Mindi River the French started to build a diversion, called the "Mindi diversion," taking the waters of the Mindi River—

Mr. WANGER. That is on the east side of the railroad and parallel to it?

Mr. STEVENS. Yes; down here through to Admiralty Bay, and to let it come into the canal at a certain point down here [indicating]. The water of the Mindi River is perfectly pure and good, but when it gets low the tide backs in and makes it brackish. The French laid a small water main from there down to Monkey Hill, and put in a tank there, and then laid a 4-inch main to Cristobal. They used to use this water for ordinary purposes; but not for drinking.

Our new 20-inch main comes down from the big reservoir, which is a mile and a half above there, into Colon; and when the water supply from the reservoir gave out—I was there for two or three days and knew what was going on—I went to test the water at the Mindi River, drank it, but said at once that it was out of the question to attempt to drink that water, and that it could not be used. But I said it could be used for the water closets and such other purposes in Cristobal through the old French main, and we did use it for those purposes, but not for drinking, because they had plenty of rain water in tanks, and that was hauled.

Now, the point that I wish to make is that not a drop of salt or brackish water was ever pumped into the Colon main for the reason that it was physically impossible to do so; there was no connection between the pump and the main, and there never has been.

Mr. WANGER. The connection was only with the main leading from Cristobal, and that was used only for flushing and such purposes?

Mr. STEVENS. Yes. Until some way can be found to force water through the suction end of a pump it will be impossible to do what it has been claimed was done. It would be just as impossible to pump water from the Washington main into the mains of the city of Albany as it would have been down here, because there is no connection between the two. The drinking water supply was brought from 19 miles up the railroad where we have splendid water; there is no better water in the United States.

Mr. WANGER. The charge was also made that it was contemplated to build a standpipe, and after an expense of \$3,500 had been incurred in putting in material it was found that the intended site was unfit, and that it involved a greater expenditure than that amount to get the material away.

Mr. STEVENS. The original plan for the Colon water supply involved putting in a large tank at Monkey Hill, about where the old French one was, only on a larger hill—a 500,000 gallon tank. The water was to be brought down and pumped up, and from there given a head of about 135 feet. In addition, they had figured on putting another tank of smaller capacity in the town of Colon; but to my mind that was unnecessary, because the one tank at Monkey Hill would give all the head necessary. Now, assuming that we build a lock canal, and we will be at work seven or eight years, we must have a water supply there at Gatun. We had accumulated a few carloads of sand and crushed rock and dug some holes in the ground 5 or 6 feet deep—probably 15 or 20 of them—and probably we have spent altogether three or four hundred dollars; but I immediately said that I did not believe we needed the second tank at Colon.

I think the chances are at least even that we will build the lock canal, and we must establish a large town for the Gatun improvement. We will probably have 4,000 or 5,000 people there. Then we must have a tank there. Therefore, to avoid the expense of providing another tank at Gatun, I stopped the work on that tank at Colon. I am going to reserve that for Gatun. If a lock canal is decided upon, I would immediately put up the tank at Gatun.

Mr. WANGER. Prior to the report of the Board of Consulting Engineers there was no proposition forcefully presented for a dam at Gatun, was there? I mean that the plans which had been presented, either officially or in such way as to give weight to them, did not contemplate such an erection; and therefore prior to that time your attention was not directed to the necessity of having your main water supply at Gatun?

Mr. STEVENS. That is the idea. You see, under any plan whereby you dredge from Colon clear through to Gamboa—a sea-level proposition, for instance—there will never be any very large number of people living along the line of the canal. The people who operate the dredges will live on their own ships. There was not any strong recommendation for a dam at Gatun until the recommendation of the board.

Mr. WANGER. Are there any other problems connected with the Colon terminal?

Mr. STEVENS. I might say, in explanation, to the gentleman who asked me about a breakwater at Colon that that was talked of last year. That was from this point here [indicating] across to here [indicating on map], and inclosing this entire area. Now, both the minority and the majority members of the committee recommended that a breakwater be built along here [indicating on map], a small breakwater here, and another one here. It is shown by these lines [indicating]. But there is a question whether that breakwater will be needed; that, in other words, it would be better to dredge this channel here [indicating] and then wait a year or two to see whether it will stay open without these breakwaters, which can be built later.

Mr. RUSSELL. Mr. Stevens, might I ask you which type of canal you recommend?

Mr. STEVENS. I am in favor of the lock type.

Mr. RUSSELL. Why?

Mr. STEVENS. Because I think it is a better canal.

Mr. RUSSELL. For what reasons?

Mr. STEVENS. Because it will handle ships as quickly—it will handle them more safely; and because it will cost the United States Government about \$2,300,000 less a year to maintain owing to the difference in capital account.

Mr. RUSSELL. You say that a lock canal will handle more ships?

Mr. STEVENS. It will handle as many; its capacity is as great.

Mr. RUSSELL. More cheaply?

Mr. STEVENS. I think so.

Mr. RUSSELL. Why? Understand me, I am not endeavoring to argue with you, because I do not know anything at all about it.

Mr. STEVENS. In computing the cost of the canal you must take into account the interest charged. The figures on the face, which I dispute, show \$107,000,000 excess cost of a so-called sea-level canal. I think it will be nearer \$140,000,000; I am absolutely sure it will be \$120,000,000. At 2 per cent that is a \$2,400,000 handicap that you will have to pay every year, and somebody has got to put it up.

Mr. LOVERING. And that is so many years before it is available?

Mr. STEVENS. Yes.

Mr. ADAMSON. Is not that compensated for by greater expense in operating account?

Mr. STEVENS. No, sir; there will be a net difference of \$2,400,000 a year.

Mr. ADAMSON. How many locks do you contemplate?

Mr. STEVENS. Three on the north end and three on the south end.

Mr. ADAMSON. It will cost something to keep them in operation?

Mr. STEVENS. Sure; but that is allowed for in these figures.

Mr. ADAMSON. How long do you estimate it will take to open and shut them when vessels are passing through?

Mr. STEVENS. An hour or an hour and a half.

Mr. RICHARDSON. You say you can afterwards change a lock canal into a sea-level canal?

Mr. STEVENS. Exactly.

Mr. ADAMSON. Would it not cost just as much to do it now?

Mr. STEVENS. No, sir; it would not, in this way: This is a long story, and I think I can at least make my position clear better by your allowing me to talk a few words without asking questions. I went down there a sea-level canal man. I have been an engineer for a long time. I have had over thirty years of practical experience, and I have been a student, and am yet, and there have been but few descriptions or articles written about the Panama Canal from the time of Philip of Spain that I have not read. Lots of it I have forgotten, and I may say I am glad of that. Philip issued an edict three hundred years ago that if any man mentioned the Panama Canal in his hearing he would cut off his head, and I feel like that myself sometimes.

I went down there with a predilection in favor of a sea-level canal, with a picture in my mind of a wide expanse of blue, rippling water

and great ships plowing their way through it, like the Straits of Magellan, minus the current, and I said to myself, "It is only a little more depth to dig and a little more money, but we can do it." Before I had been down there long I saw it was a different proposition—different from the Isthmus of Suez. I had not taken into consideration before the fact that there was a mountain range there, and that there were streams there with 100,000 cubic feet of water to flow into it. We have found there an aggregate of something like eighteen or twenty streams pouring into that sewer down below the Chagres River. I had not taken into consideration the currents, with all the difference of water they would make in a narrow canal.

In a general way I understand the operation of a lock, having been connected with the Great Northern Railway for many years, with interests largely connected with the Sault Ste. Marie Canal, and I had as an outsider and spectator watched those locks. In fact, twice, taking a vacation, I went out there, and was there a week at a time twice and watched the operation of that canal.

But after looking the ground over on the Isthmus, I said to myself that I did not believe in a sea-level proposition for one or two generations. Then I began to study the lock proposition, and the more I studied it the more I became convinced of its wisdom.

The one great reason for the theoretical preference for a sea-level canal is that there is an entirely erroneous notion of what is proposed for a sea-level canal under the plan proposed. If, as I said, we had the prospect of a wide canal on the Isthmus of Panama, and we could get it in a reasonable time, I would be heartily in favor of it.

Mr. WANGER. What do you mean by a wide canal?

Mr. STEVENS. I mean a wide canal instead of a 150-foot canal; a width in some cases only one-half more than the width of the vessel, with only 4 feet of water under her keel. If we could have a canal 500 feet wide, with 45 feet of water, that would do.

Mr. ADAMSON. Would that be completed with a billion dollars?

Mr. STEVENS. I do not think it could be.

Mr. KENNEDY. Through a canal of the kind proposed, a large ship could not run with its own power?

Mr. STEVENS. I do not believe it could.

Mr. WANGER. You said a canal less than half the width of the vessel. You meant a canal less than double the width of the vessel?

Mr. STEVENS. Yes; I meant a ship would occupy about one-half of the space. It has been admitted by every one of the expert engineers—I do not pretend to be an expert hydraulic engineer myself—but I do not suppose, with the amount of water that would be let into the canal, you could prevent currents from running through the crooked part of the canal there, and it is very crooked, running approximately 3 miles per hour, or 2.64 miles.

Mr. ADAMSON. Do you mean to have wide places, in the nature of side tracks on a railroad?

Mr. STEVENS. That would have to be allowed for, although it has not been allowed for in the plans and estimates.

Mr. ADAMSON. Is your plan for a lock canal that way?

Mr. STEVENS. The lock canal is wide enough for passing, and throughout at least 80 per cent of it the ships can pass practically at full speed.

MR. ADAMSON. I want to ask you about the Gatun dam. Have you found bed rock at Gatun?

MR. STEVENS. We have found rock.

MR. ADAMSON. How far down?

MR. STEVENS. From 10 to 15 or 20 feet below the surface; from there as far as we have gone. I have gone 60 feet below the level of the sea.

MR. ADAMSON. What have you found across the Chagres Valley?

MR. STEVENS. We have found the same strip across the Chagres Valley and across the old channel of the river. With the exception of two places, we found this same rock so far as we have gone.

MR. WANGER. The rock to which you refer has also been called indurated clay?

MR. STEVENS. Yes, sir.

MR. ADAMSON. Do you intend to build a dam across a place like that, or laying an impenetrable veil down to bed rock?

MR. STEVENS. Yes, sir. It is material amply strong enough in every respect.

THE CHAIRMAN. Mr. Stevens, have you answered fully to your own mind this question of why you have preferred the lock canal?

MR. STEVENS. No, sir; I have not answered it fully.

THE CHAIRMAN. You have been carried away by questions?

MR. STEVENS. Yes. I believe, as I said before, the lock canal will handle ships quicker. It has been demonstrated by figures by all these maritime people, by these engineers at least, that the sea-level canal perhaps will take the smallest class of ships and will probably put them through a little quicker; but as to medium-sized ships there will be no difference. As to the larger ships, the lock canal will put them through faster than a sea-level canal. With a sea-level canal it means that no ship can move on her own steam or have steerage way with less than 5 or 7 miles' speed, which would be, to my mind, in that canal, with submerged banks and very largely rock, a dangerous and impossible performance. In fact, I believe that the largest ships that we have now would never get through. They would be in there a day or two, and after a while pull out and go around the Horn.

I do not see how you can put a ship of 80-feet beam through such a channel and around those sharp curves. It is a known fact that a ship does not steer well in shallow water. It is very hard to control a ship in shallow water. The chief engineer of the Suez Canal admits that as a fact. You will find it in his statement in the record of the Consulting Board.

I came up to New York from the Isthmus on a little Panama steamship the other day, which is less than 300 feet long. When we got up to Barnegat—you know we parallel the coast along Barnegat Bay for 40 miles—I noticed the ship then—and she is a splendid little ship, quick and active as a bird—and I noticed she was not behaving well, and I said to the captain, "What is the matter? What is the matter with your quartermaster? You are not steering straight along the coast." He said, "Do you not know that a ship in shallow water does not steer well?" I said, "Do you mean to say that that man can not steer well without going 40 or 50 feet out of his course?" He said, "It is a fact that a ship will yaw in shallow water."

With ships of eighteen or twenty thousand tons, like the *New York* and *Minnesota*, I do not see how you can go through the ship canal and float them, and I knew much about the designing of those ships years ago. They have 76 feet 8 inches beam and are 630 feet long from water line to water line and draw 35 feet fully loaded.

Mr. TOWNSEND. How will your lock canal remedy that?

Mr. STEVENS. That would be remedied in a lock canal, because in that case we would have a wide channel. We have from Gatun, through this large lock here, until you get away up here [indicating on map]—you have a thousand-foot channel, a thousand feet in width, with water nowhere less than 45 feet. All this white here [indicating on map] is lake. Wherever it is colored white it means 45 feet of water or more. Wherever it is colored blue it is less than 45 feet.

Mr. ADAMSON. You have never experimented anywhere in lifting a ship 800 feet long and 80-foot beam up to an 85-foot level?

Mr. STEVENS. No, sir. We only figure on a 28-foot lift in these locks at one time. There are three tide locks.

Mr. ADAMSON. They are congregated, are they not?

Mr. STEVENS. No, sir. Only one at a time. You have only to eat one meal at a time, even if you take three meals a day.

Mr. FRED C. STEVENS. What is the lift of the "Soo" lock?

Mr. STEVENS. About 20 feet.

Mr. FRED C. STEVENS. Then you would only lift it about 8 feet more?

Mr. STEVENS. Yes, sir.

I would like to explain that before I get away from it. The difference in cost we have figured—I say "we;" we give competent authority as near as we can—we have figured that in fifty years there may be from thirty-five to forty millions of tons brought in through this canal; but we know absolutely beyond question that we have enough water for lockage purposes to handle from sixty to seventy millions a year under the present plan, and that can be augmented by the addition of more storage facilities at Alhajuela and elsewhere when the time comes when the lock canal does not give sufficient accommodations to handle the tonnage, either by reason of lack of water or lack of size; and long before that time—we will come to that gradually, in generations—the difference in the cost of construction of the lock and the sea-level canal at compound interest at 2 per cent added to the difference in cost of operation in fifty years will furnish a fund that will be sufficient to transform the lock canal into a true sea-level canal of ample capacity, a canal entirely different from the one now proposed.

Mr. ADAMSON. If that is done you would encounter the same difficulties you have been describing, would you not?

Mr. STEVENS. I say a true sea-level canal, a good wide one. One hundred and fifty million dollars for fifty or one hundred years at compound interest would be a great deal of money.

One of you gentlemen asked me a question about Gamboa dam.

Mr. TOWNSEND. I would like you to tell what the effect of the Chagres River is going to be on a lock canal.

Mr. STEVENS. To my mind there is only one problem of engineering down there. Of course, these are gigantic matters as to handling, but they are not mysteries. The one great problem in the construc-

tion of any canal down there is the control of the Chagres River. That overshadows everything else. The rest, to my mind, are details in comparison. The line of the canal under either plan follows the valley of the Chagres River. There you have some 30 crossings from the bay here [indicating on map] at Colon, here, to this point. Here is the valley of the Chagres. Going upstream—

Mr. WANGER. The words "here at this point," are not very definite on the notes.

Mr. STEVENS. That is at Gamboa. It swings sharply to the east at right angles and goes up to the headwaters here [indicating] I do not know how many miles; then it follows up the valley of the Obispo and its waters until it reaches the summit here [indicating], and three valleys leading into the Little Rio Grande stream. Now, while there are quite a number of streams here [indicating], they can all be taken care of without a great amount of trouble and expense. But the main stream to be considered is the Chagres River.

There have been records, since intelligent records have been kept, that the flow here in Gamboa in the driest season known has gotten down to 388 cubic feet per second. Bear that in mind for the sake of contrast. There are records here at Gamboa where the known discharge through the gorge here [indicating] at flood times has been up to 60,000 cubic feet per second. There are evidences of records, estimated by very careful lines and high-water marks, that in 1879, by tradition—and it is hardly fair to say tradition, because it is no further back; but by evidences—I do not know what they are; I take my authority from General Abbot—but it appears one discharge might have occurred here [indicating] at 136,000 cubic feet per second.

Mr. WANGER. That is at Bohio?

Mr. STEVENS. Yes, sir. What I want to bring out is the fact of the great difference between high water and low water discharge in this river.

Of course, any such body of water as twenty-five or thirty thousand feet discharge immediately into the canal, sea level of otherwise, right here at Gamboa, would be absolutely prohibitive. In the first place, you could not navigate, and, in the second place, it would tear the canal all to pieces.

Mr. ADAMSON. With a width of 500 feet you could?

Mr. STEVENS. No, sir; you could not at all.

Mr. WANGER. Let me ask you as to the actual measured discharge at Gamboa. Was it not 58,720 feet per second in 1890?

Mr. STEVENS. That is my recollection.

Mr. WANGER. And the highest estimated discharge in the flood of 1879 was 79,000?

Mr. STEVENS. That was the actual measure. But then they have records—and General Abbott is pretty good authority—they have records to the effect it might have gone to 136,000.

Mr. WANGER. Did not he say that was at Bohio?

Mr. STEVENS. I am not certain about it.

Mr. WANGER. I think you will find it in his report in connection with the Board of Consulting Engineers.

Mr. ADAMSON. Is it not the plan to excavate the Chagres River for a mile and let it come down to the level?

Mr. STEVENS. No; I would have the lake extending half the distance, and—

Mr. TOWNSEND. What is your plan?

Mr. STEVENS. The only way that is feasible is to build a dam where there is a very excellent location, and by going down 50 feet—and by the way, the valley of the river there is 50 feet above the sea level, and it so happens that by boring down 50 feet you strike rock. By building a dam there 220 feet long from mountain to mountain, and going down to this rock, it is possible to impound, as shown here colored in blue, all the waters of the Chagres River up here for 25 miles, probably, or 20 miles at least. That dam would be 180 feet high.

The CHAIRMAN. Mr. Stevens, the hour has arrived when we must adjourn. When would it suit you to resume your statement?

Mr. STEVENS. At any time.

The CHAIRMAN. What time shall we take a recess to?

Mr. MANN. Would it be more pleasing or agreeable to you to go ahead this afternoon or to-morrow?

Mr. STEVENS. I can suit your convenience. I am not in very good shape physically. I was sick all night.

Mr. MANN. Maybe you would prefer to go over until to-morrow?

Mr. STEVENS. No; I may be dead by that time. I am at your orders.

The CHAIRMAN. Very well; we will then take a recess until half past 2 this afternoon.

AFTER RECESS.

The committee met at 2.30 o'clock p. m., pursuant to adjournment.

STATEMENT OF MR. JOHN F. STEVENS, CHIEF ENGINEER ISTHMIAN CANAL COMMISSION—Continued.

Mr. WANGER. How long do you estimate it will take to build the locks and dams called for by the lock project?

Mr. STEVENS. I think it is possible to build them in six years, although I have always figured on seven or eight years in order to be conservative and safe.

Mr. WANGER. Could that time be reduced any if it became necessary to build the Sosa dam?

Mr. STEVENS. The Sosa dam and the other two dams are small and they would not enter into the calculation. In fact, the next few months I hardly expect to do very much, if anything, on them.

Mr. WANGER. Could you carry on all those operations simultaneously?

Mr. STEVENS. Yes, sir.

Mr. WANGER. How long a time do you estimate for completing the excavation of the Culebra cut under the lock plan?

Mr. STEVENS. It should be done in practically the same length of time—not to exceed six years.

Mr. WANGER. Which do you think involves the greater uncertainty,

the excavation at Culebra or the building of the Gatun dam and locks?

Mr. STEVENS. In point of time?

Mr. WANGER. Yes, sir.

Mr. STEVENS. I do not think there is any great uncertainty about either. As a matter of fact, the bulk of the work, the concentration of the work at the dam and the locks, particularly the locks, is much worse than the Culebra cut; but, on the other hand, it is work that you can do at night to very good advantage, whereas in the Culebra cut you can not get the same amount of efficiency at night as in the daytime. There are about 2,500,000 yards of material to dig out for the locks at Gatun, but it is a very short haul, not to exceed 3,000 feet, the extreme haul, and nearly all of it can be handled by steam shovels; and it is not necessary to take out all of that excavation before you commence the masonry on the lock walls and chambers. So in figuring you must figure when you have half the excavation taken out then you would be ready to commence the masonry. Although I confess some of the engineers do not agree with me, I think the Gatun dam and locks can be built in practically the same time as the Culebra cut under the lock plan. I know I am alone in that opinion on the Commission.

Mr. WANGER. That project contemplates a usable length of 900 feet in each lock?

Mr. STEVENS. Yes, sir.

Mr. WANGER. And 55 feet additional for extra safety gates?

Mr. STEVENS. Yes, sir.

Mr. WANGER. How much space is required between lock chambers or at the termini in addition?

Mr. STEVENS. At the termini the walls that have been estimated for are 1,200 feet outside of the gates.

Mr. WANGER. On each side?

Mr. STEVENS. Yes, sir.

Mr. WANGER. Making a total length of what for the Gatun lock structure?

Mr. STEVENS. The whole thing?

Mr. WANGER. Yes, sir.

Mr. STEVENS. I do not now recall what that is. You understand the one approach—the low approach, for instance—at Gatun at the north end, these walls [indicating on map] will simply be the walls of the canal proper, so that really there would be about 3,700 or 3,800 feet. I do not recall the exact figures.

Mr. WANGER. Have you definitely ascertained that there is a suitable foundation all that length?

Mr. STEVENS. Yes, sir.

Mr. WANGER. At the time of the visit of the engineers the walls had not been extended to establish that fact?

Mr. STEVENS. No, sir.

Mr. WANGER. Since then you have determined that fact?

Mr. STEVENS. Yes, sir. I took a strip about 600 feet in length, making the center of it about the side line where the present locks will be built, and I took a series of three, and in some places four, holes—110 holes, 3,700 feet in length—and I found, after the strip of clay on top, from 10 to 20 feet of this indurated rock, in most

cases 60 feet below sea level. The lower I went down the deeper I naturally went with my borings, so as to be certain that I had the rock under my structure. It is possible there may be a great deal more, but I stopped when I got there, because I knew that was all I wanted.

Mr. WANGER. You know there is that much, but you do not know how much more?

Mr. STEVENS. No, sir.

Mr. WANGER. The entire lock structure would be founded on the same indurated clay?

Mr. STEVENS. Yes, sir. I know the same material crops out on the Chagres River and along the line of the old French excavation and above the banks here [indicating on map] clear down to the mouth of the Mindi, something like 5 miles, and at Mount Hope or Monkey Hill, so called. I had a drill there—a 6-inch drill—and I started to drill to see what was under it, thinking possibly that I might strike an artesian well. I think we will in the future. And I found indurated clay of the same formation and the same belt, and I went 415 feet without any change in the formation before I got through.

Mr. TOWNSEND. Is the indurated clay impervious to water?

Mr. STEVENS. Yes, sir.

Mr. ESCH. Is that of the same character as in the Culebra Cut?

Mr. STEVENS. No, sir; it is entirely different.

Mr. WANGER. Is that the same material that was in the dry dock at Cristobal?

Mr. STEVENS. Yes, sir. It is within half a mile of the Cristobal dry dock, right on that flat, near the little station.

Mr. WANGER. The walls of the dry dock have been exposed for a great many years?

Mr. STEVENS. Yes, sir. I do not know just when it was built, but I think it must have been built fifteen or twenty years ago.

Mr. WANGER. Are they still firm?

Mr. STEVENS. Yes, sir. There is no facing to it; it is simply the natural rock.

Mr. WANGER. You are doubtless familiar with the project of Mr. Lindon W. Bates?

Mr. STEVENS. Yes, sir. I made a study of it last year.

Mr. WANGER. Do you see any advantage in his proposition to locate a lock at Boca Mindi?

Mr. STEVENS. No, sir; I never have. In fact, I never have been thoroughly converted to the belief that we should build within reasonable shooting distance of ships. In that respect you may recall the minority report as to the La Boca proposition. I dissented from that opinion.

Mr. WANGER. Do you regard the Gatun locks as being too near shooting distance?

Mr. STEVENS. I am not a military man, but I should say no. They are 7 or 8 miles away, and they are out of view. I suppose they could find them with range finders.

Mr. WANGER. Under the lock project the Gatun dam would provide a lake of what area?

Mr. STEVENS. About 118 to 120 square miles, as near as we can figure it.

Mr. WANGER. Would there not be a good deal of evaporation from a lake of that size?

Mr. STEVENS. Yes, sir; a tremendous evaporation, almost directly in proportion to the area exposed.

Mr. WANGER. If the summit level of the canal was but 60 feet, would there not be a good deal less evaporation?

Mr. STEVENS. There would be less evaporation in proportion to the less number of square miles of lake exposed.

Mr. ADAMSON. Have you formed any opinion as to whether the inflow of the Chagres and all those other streams would equal the evaporation from the lake?

Mr. STEVENS. Yes, sir. Those calculations have all been worked out. They are shown in the committee's report, the loss of water from all sources, leakage, power purposes, evaporation, and, I think, seepage, and on that was based the calculation that there is plenty of water in the Gatun lock to take off between sixty and seventy million tons a year.

Mr. ADAMSON. We rode around the canal from Bohio in a boat, and my recollection is that there was another considerable river on the left?

Mr. STEVENS. That is the Trinidad. That comes in here [indicating on map] and the Gatun is here. [Indicating on map.]

Mr. WANGER. About how much less time would it take to construct the locks and dams for a 60-foot summit level canal?

Mr. STEVENS. For 60 feet you would take out one lock on each side. There would be no difference in point of time, but instead of having three locks you would have two, or instead of six you would have four on the twin bases.

Mr. WANGER. You would require over a thousand feet less of foundation work?

Mr. STEVENS. Yes, sir. You would shorten it just that much. Theoretically it would shorten the length of time one-third, two and one-half years, practically it would not.

Mr. WANGER. The 60-foot level would require the building of the Gamboa dam?

Mr. STEVENS. Yes, sir. You see, at this point here [indicating on map], where the Chagres strikes into the valley, it is + 50—that is, the elevation of the valley is 50 feet above sea level. If you built the locks on the summit level here [indicating on map], 60 feet, you would practically have 10 feet of water, and with the floods coming down the Chagres that would not do at all. You would have to hold this water back, so as to get deep water here [indicating on map].

Mr. WANGER. It would take, in your judgment, how long to build the Gamboa dam of masonry?

Mr. STEVENS. From three to five years.

Mr. WANGER. That would be simultaneously with the building of the locks?

Mr. STEVENS. Yes, sir.

Mr. ADAMSON. If you should build simultaneously, could you get the requisite material from the excavation in the cut?

Mr. STEVENS. For the Gamboa dam?

Mr. ADAMSON. Yes, sir.

Mr. STEVENS. I think so; yes, sir. But you understand that it is not proposed to build an earthen dam at Gamboa.

Mr. ADAMSON. I understand; but in the Culebra cut there is stone?

Mr. STEVENS. Not good stone for the concrete. We would have to have that brought in, although I am not certain. I have selected a place to get the rock for the Gatun work, if we do that.

Mr. ADAMSON. I am talking of using the same thing twice; where you take it away, use it somewhere else.

Mr. STEVENS. But the majority of the rock in the Culebra cut is not good masonry rock. It is not a good grade. It is very hard and expensive to segregate it from the great mass.

Mr. WANGER. How is the rock at Bohio?

Mr. STEVENS. It is not good. It is too soft.

The CHAIRMAN. The lake or basin there resulting from the building of the Gatun dam, would it fill in a single season?

Mr. STEVENS. Yes, sir; it would consume a year, taking the wet and dry seasons, to fill it.

The CHAIRMAN. With that 85-foot dam, using that lake for navigation purposes, where you begin excavation in order to get sufficient depth, at what point?

Mr. STEVENS. At a point near San Pablo, where the Panama Railroad crosses the Chagres River, right here [indicating on map], and here [indicating on map]. At those two points you would have more than 45 feet of water. The first dike is 25 miles, perhaps, and from there on [indicating on map] the excavation would be for a distance of from 25 to 27 miles.

Mr. ADAMSON. Is there any saving in excavation at all in favor of the lock canal?

Mr. STEVENS. Yes, sir. The difference between Bohio and Gatun, that 8 or 9 miles [indicating on map], there is a saving of \$11,000,000.

Mr. ADAMSON. Of excavation?

Mr. STEVENS. Yes, sir.

The CHAIRMAN. What is the total amount of excavation for the canal with the 85-foot level?

Mr. STEVENS. Nobody can say until we have had time to readjust our cross sections to the new plan. It has been stated variously from 46,000,000 to 53,000,000 yards. I think myself it is something under 50,000,000 yards.

The CHAIRMAN. What will be the total excavation, according to the sea-level plan?

Mr. STEVENS. Through the Culebra cut there are from 110,000,000 to 112,000,000 yards.

The CHAIRMAN. And what would be the balance?

Mr. STEVENS. The balance has been calculated as between 260,000,000 and 280,000,000 yards. I do not think anybody knows.

The CHAIRMAN. There would be a difference of 235,000,000 cubic yards between the two schemes?

Mr. STEVENS. Yes, sir; possibly 220,000,000 yards would cover it.

The CHAIRMAN. Under favorable circumstances in the Culebra cut what amount of excavation can you do in a day of twenty-four hours day after day?

Mr. STEVENS. It depends altogether on what elevation you are working at. Of course you understand that the higher up you are the cheaper and quicker you can handle the material. In the dry season it is much dryer, and therefore it is easier to handle the material. When you get further down the rock is harder and there

is no earth at all. Then, again, at the top you are working in a wider space, and you have more chance to handle yourself—that is, the men have better opportunity to work, and the cars going out to the dumping ground are lighter, and as a consequence there is less cost for transportation. I have always figured that we should handle from thirty to forty thousand yards a day easily.

Mr. ESCH. How many steam shovels can you work?

Mr. STEVENS. That is something we will have to prove.

The CHAIRMAN. That will be about 1,000,000 yards a month?

Mr. STEVENS. Yes, sir; I had hoped to do that. The Chicago drainage canal, which was very largely rock or alluvial drift, averaged about 500 yards per shovel, but they did not do all their work with shovels. They handled a great deal of it with carriers. We have not the advantage they had. Out of 50,000,000 yards to be taken out of Culebra Cut, I do not think more than 2,500,000 yards can be disposed of without hauling. If we put the waste back in a place where the water can get at it, it is coming back into the canal system. It takes a large area to pile 1,000,000 yards.

Mr. ADAMSON. And you will aid sanitation by doing that?

Mr. STEVENS. Yes, sir.

Mr. ADAMSON. I would like to ask you if in the aggregate dams built with the rocks will be compensated in cost by the saving in excavation?

Mr. STEVENS. Yes, sir; and a great deal more. I just mentioned that difference in the two estimates between the dam at Bohio and the dam at Gamboa, at \$11,000,000.

Mr. KENNEDY. The problem of taking care of the Chagres River must be quite different under these two different plans?

Mr. STEVENS. Yes, sir; entirely so.

Mr. ADAMSON. Has anybody asked you as to the material for the construction of these great locks, will it be concrete with the necessary cement covering?

Mr. STEVENS. Concrete.

Mr. ADAMSON. Entirely?

Mr. STEVENS. Yes, sir; our expert lock man may want to use bricks under the lock floors. I do not know about that.

Mr. ESCH. How many cubic yards of soil could you use on the Gatun dam?

Mr. STEVENS. There is no limit; about 21,000,000 yards according to the design.

Mr. ESCH. That would take care of a good deal from the Culebra Cut?

Mr. STEVENS. Yes, sir; the majority of that is to be built by sluicing. The plan proposed is this: All this material in here [indicating on map] is very nice material.

Mr. WANGER. Between the Gatun dam—

Mr. STEVENS. And the sea. That material we would dredge here [indicating on map]. The old French canal is up here [indicating on map], and we could get this out [indicating on map] in three weeks' time. Dredge the material out here [indicating on map], and drop it right here [indicating on map] at the foot of the dam. There [indicating on map] we would repump it right into this dam, and let the water run away and compact the material. At the same time we would undoubtedly bring down material from Culebra cut,

running out on this dump [indicating on map], and let the water soak through, and the whole thing would become compact.

Speaking about the immense amount of material, I figure on from 100 to 125 carloads per day needed of material to build the locks. That is quite a traffic in addition to the commercial and ordinary business of the railroad, due to the amount of waste that is to be hauled from Culebra cut. I would not haul half of it over the railroad. I have a location on the coast where there is as fine rock for concrete as I ever saw, and there is 60 foot of water. That is about 20 miles. I would spout the material right into the scows, and then take the tugs right up the canal and drop it right at the Gatun locks. In other words, it will eliminate entirely the question of railroad transportation to the locks. It is the prettiest place I ever saw.

MR. ADAMSON. Would it not be equally as easy to reach the other locks?

MR. STEVENS. Yes, sir. Two of the locks, under this plan, are right at deep water now. The only question remaining is sand when you get here [indicating on map], on the Chagres River, way above Gatun. There is one deposit of sand on the beach near Panama. I have kept the location in mind. There are about 3,000,000 cubic yards of splendid building sand. It is possible we may have to haul that on cars to Gatun, but I think we can pump it with hydraulics right into the scows, and then into the dump cars, and it will not cost but a very few cents per yard.

THE CHAIRMAN. How much of the area of overflows belongs now to the United States?

MR. STEVENS. There has never been a close calculation made, but I should say between 20 and 40 per cent.

THE CHAIRMAN. What do you estimate the damage to the remaining portion would cost?

MR. STEVENS. I do not know, but I do not think, taking the amount of acreage there—50,000 acres—it is more than from \$300,000 to \$500,000.

THE CHAIRMAN. How many acres would that cover?

MR. STEVENS. I figure on the basis of \$7 an acre; that is, between 50,000 and 60,000 acres. Some gentlemen have overlooked, I think, the fact entirely that at Gatun the land on which the houses are built belongs to the United States, although the houses belong to private individuals. I have bought up unexpired leases of a number of houses of about the same class in the last six months and destroyed them, and I have counted the houses in Gatun, and there are approximately 58 where the Government owns the land now. Those 58 houses would not cost on an average more than \$125 to \$150 apiece, and the people would be very glad to take that amount of money and get out. So six or seven thousand dollars would clear out that apparently very large town, and it is the biggest one—

MR. ADAMSON. What has become of the claim of the old Spanish governor who claimed that he owned 28,000,000 acres?

MR. STEVENS. I do not know. There is a great amount of land in controversy. We think it belongs to us, and it is claimed by us, and so I determined to ascertain what we do own and what we do not own, and I had the legal department bring some suits in ejectment, and we are carrying them through now. We have tried several cases, and in every case we have won. There was one case involving the

whole town of Empire—about 1,000 acres of land—and we have a decision finally from the supreme court that the whole territory belonged to the Panama Railroad. All that money for the leases of houses should have gone to the Panama Railroad for the last ten or fifteen years. Now we have the land and the title to it.

Mr. TOWNSEND. Do you not have any statute of limitation?

Mr. STEVENS. No, sir.

Mr. WANGER. On whose land is the church at Gatun?

Mr. STEVENS. On the land of the Panama Railroad. After you get south of Gatun, at the first little bridge about a quarter of a mile, about one-third of the distance from the town, from the railroad station up to the long bridge across the Gatun River, belongs to the United States, and then Stilson comes in there. He lives there on our land, and Stilson owns a long strip that we would have to acquire.

Mr. TOWNSEND. You could not get his land for \$7 an acre?

Mr. STEVENS. Yes, sir; it is jungle land.

Mr. TOWNSEND. He is quite a wealthy man?

Mr. STEVENS. Yes, sir.

Mr. WANGER. He has a pretty large ranch?

Mr. STEVENS. Yes, sir.

Mr. WANGER. Do you know how many acres he has in cultivation?

Mr. STEVENS. I do not think he has any.

Mr. WANGER. I mean for grazing.

Mr. STEVENS. The main grazing ground is over the hill and back to the sea, a great part on Panama Railroad land.

Mr. WANGER. Mr. Mann and I walked across it.

Mr. STEVENS. I do not know what part you were on, but I would say it was on the Panama Railroad.

Mr. WANGER. We went from the Gatun station to the engineers' camp.

Mr. STEVENS. You were on the Panama Railroad land. The only land Mr. Stilson owns is up the valley, away off to the east and south-east.

Mr. WANGER. Will Matachin be submerged by the 85-foot-elevation canal?

Mr. STEVENS. Yes, sir; the whole town of Matachin.

Mr. WANGER. And the railway station at Empire?

Mr. STEVENS. Oh, no. That is away above the elevation. You see, it is a very little raise from Colon up to Matachin. There is only the natural raise of the valley, about 50 feet at Gamboa. The tide ebbs and flows there only about 18 inches.

Mr. CUSHMAN. What is the difference in the rise and fall on the two oceans?

Mr. STEVENS. We have the record of last March—23 feet at La Boca.

Mr. WANGER. The difference between tides?

Mr. STEVENS. Yes, sir.

Mr. WANGER. What was it at Colon during the same period?

Mr. STEVENS. We did not have any high tides in March; something like 18 inches. There is about 23 feet difference in the tides at La Boca.

Mr. ADAMSON. Twenty-three feet difference in mean tides?

Mr. STEVENS. Yes, sir.

Mr. CUSHMAN. On the Atlantic side the tide rises above and falls below mean tide about how far?

Mr. STEVENS. About one-half of 18 inches, say, 10 inches.

Mr. CUSHMAN. Ten inches above and below?

Mr. STEVENS. Yes, sir.

Mr. CUSHMAN. Then, on the other side, on the Pacific coast side, it rises—

Mr. STEVENS. One-half of 23 feet, $11\frac{1}{2}$ feet.

Mr. CUSHMAN. Above and below?

Mr. STEVENS. Yes, sir.

Mr. GAINES. In a sea-level canal what effect would that difference in the tidal movement on the Pacific coast side and the Atlantic coast side have on the current through the canal?

Mr. STEVENS. It would make the current for two or three hours twice a day so you could not possibly navigate. That is why the lock is interposed at that point.

Mr. CUSHMAN. That is, there would be at least one lock in a sea-level canal?

Mr. STEVENS. Yes, sir; part of the time you would lock the ships out. A tidal lock, by the way, is very much more difficult to operate than a stillway, owing to the rush of the water through when the gates are opened.

Mr. ADAMSON. Would not a tidal lock operate to keep the drift from coming in?

Mr. STEVENS. I do not think so. I think you could take men and keep it clear. You mean the silt?

Mr. ADAMSON. Yes, sir.

Mr. STEVENS. That is a proposition nobody knows until they try it.

Mr. WANGER. At the Gatun dam you have two depressions?

Mr. STEVENS. Yes, sir; two depressions in the river.

Mr. WANGER. One is about 204 feet deep?

Mr. STEVENS. Yes, sir; and the other about 258 feet.

Mr. WANGER. And there is some water flowing at different points?

Mr. STEVENS. We found in one of the gorges, something like 200 feet below the bed of the river, in putting down the pipes, after going through the fine sand and fine clay, that we got into gravel, and in two or three pipes brought out a small amount of water. The pipes, as I recall it, were about $2\frac{1}{2}$ inches in diameter, and in several instances some 3 or 4, as I recall. The top of the pipes were about 10 feet above the level of the water at Gatun, and the water flowed out a little over the top of the pipes an inch.

Mr. WANGER. That would indicate that the source of the water was that much higher than the level of the river?

Mr. STEVENS. Yes, sir. Wherever that water got its head, it must have been at a point higher than the river was at Bohio, 10 miles away, and how it got that pressure, or whether by pressure of the headwaters in the hills, no mortal man can say.

Mr. WANGER. Is there any way of determining by boring, with reasonable certainty, the source of that water?

Mr. STEVENS. I do not know how you could tell. I would not undertake to say.

Mr. WANGER. I understood Mr. Stearns to say that possibly by using a 4-inch pipe—you used a 2-inch pipe?

Mr. STEVENS. Yes, sir.

Mr. WANGER. You could determine better the volume of the flow?

Mr. STEVENS. The larger the pipe or the more line you put down. But your question was how to determine where that water comes from?

Mr. WANGER. Whether it comes from the bed of Chagres or some miles above the dam site.

Mr. STEVENS. We know that it could not have come less than 10 feet above the stage of the water at the time it was flowing; that would be a mechanical impossibility.

Mr. WANGER. Suppose it did come several miles above, would it not very largely increase if the elevation at Gatun was raised 5 feet?

Mr. STEVENS. Undoubtedly.

Mr. WANGER. And might it not seriously deplete the supply of water?

Mr. STEVENS. No, sir.

Mr. ESCH. That condition would indicate an impervious rock?

Mr. STEVENS. That is what we claim.

Mr. ADAMSON. In the case of a broken or irregular strata of stone where it is fully cut above and not so below, is not the water forced up and then down the hill?

Mr. STEVENS. Water can never reach higher than its source.

Mr. ADAMSON. I understand, but if the strata be broken or cracked the water will follow the breaks or cracks?

Mr. STEVENS. If it has a head and it is quite a stream.

Mr. ADAMSON. But if it goes above the head it stops?

Mr. STEVENS. Yes, sir.

Mr. ESCH. Do those two big curves at Gatun present any mechanical difficulties that can not be overcome?

Mr. STEVENS. Not to my mind. That is the cause for the great discussion between the dam and no dam people. There are only three ways in which an earthen dam can fail. If it is too slight, the pressure behind will push it away. That is what happened to the Austin dam in Texas. If the water raises higher than the course in the case of an earthen dam, and it goes over the top and flows down the slope, it will wear away the earth. That is what happened at Johnstown; the spillway was not big enough. The spillway was too small and the water went over the top. Another way is for the water to percolate underneath, and then the only way it can get out is at the toe of the dam. Then it will have the same effect. There is no other way that an earthen dam can fail that I know of. I understand some people say that an earthquake will knock it out, but I think an earthquake will strengthen it.

Mr. WANGER. A dam might fail in its use and not remain in place?

Mr. STEVENS. Yes, sir; by not holding the water. I do not think there is the slightest occasion for apprehension at Gatun.

Mr. CUSHMAN. There could be enough water pressure if the dam was not constructed in the proper way?

Mr. STEVENS. Yes, sir; that is the first way I mentioned. The Gatun dam is only on paper. It may never be any other way. You take the plan of the dam. I can give you the dimensions and weights. Here [indicating] is a chart which shows the proposed dams and the cross sections of other dams that are in existence and have been for some years. First, you all know that only the depth of water affects the pressure. In other words, if we only had 1 foot of water, the-

oretically, behind that dam you would get the same pressure as if you had 1,000,000 miles.

Mr. ESCH. That is, laterally?

Mr. STEVENS. Yes, sir; if you had 100 feet you would have 43 pounds of pressure at the bottom. The weight of the Gatun dam as proposed is 63 times the heaviest pressure that comes against it at the bottom.

Mr. ESCH. Eighty-five feet below the water level?

Mr. STEVENS. Yes, sir.

Mr. ESCH. And the head is 85 feet?

Mr. STEVENS. Yes, sir. So everyone has conceded that the dam is larger than there is any necessity for, as far as the lateral question is concerned.

This lower sketch [indicating] represents the proposed Gatun dam. You notice that long tail all the way. This [indicating] +85 means 85 feet deep at this point. This slope [indicating] is 1 on 3. One-half of the weight is right through there [indicating on chart], 375 feet, which is four times the weight of any dam on earth.

The CHAIRMAN. In addition to the surface of the water?

Mr. STEVENS. Yes, sir. Here [indicating on chart] is the bottom, 2,625 feet, a half a mile, with a slope of 1 in 25. In other words, a heavy grade. That is made for a scientific reason. If water should percolate through the dam, which it is not believed for a moment it can, it never would get over here [indicating on chart], because it will always be kept below here [indicating on chart]. It is 7 tons to the cubic yard on its foundation, or, in other words, it is 63 times the lateral pressure here [indicating on chart], and that pressure is the same as if the lake stopped right here [indicating on map].

Mr. LOVERING. Does it not increase at this slope [indicating on chart]?

Mr. STEVENS. It decreases. For instance, here [indicating] it is pressure is the same as if the lake stopped right here [indicating on chart] it is 70 feet and 29 or 30 pounds.

Mr. KENNEDY. Pounds to the square inch?

Mr. STEVENS. Yes, sir. Here is a representation of the San Leandro dam in California. That has been built for a number of years, probably twelve or fifteen years. That is entirely of earth. There it is 115 feet as against 85 feet proposed here. There the top of the dam is 120 feet and the head of water 115 feet. There [indicating on chart] is what they call selected earth. You can see the difference in the two propositions.

Here [indicating on chart] is another dam, of red clay, constructed in California. It is entirely earth and 18 or 20 feet below the surface it has rock. Here [indicating on chart] is nothing but clay and gravel, just the same as in the other dam.

Here [indicating on chart] is a very interesting dam. Of course it is small, but it shows what has been done. This is in India. There is a dam, with a total weight of 368 feet, something like 55 feet high. There is nothing there but sand in miles, and the water leaks through and around the end of it, and yet there it stands for years and years.

Mr. CUSHMAN. Can you give us any idea of the proportion be-

tween the length of this Gatun dam and the length of some of the other dams?

Mr. STEVENS. I do not know how long they are; I could not tell you.

Mr. CUSHMAN. Would the length of the various dams affect the principles you have been speaking of?

Mr. STEVENS. Not in the slightest degree.

Mr. KENNEDY. Every section of the dam is strong enough to stand, even if the water went around the earth?

Mr. STEVENS. Yes, sir.

Mr. ESCH. You think that the earthquake might improve the dam, but you do not give the reasons?

Mr. STEVENS. I do not think that an earthquake can shake down the Gatun dam. If it made a crack in it, it would simply settle.

Mr. ESCH. But more with reference to the Gamboa dam, which is to be of masonry?

Mr. STEVENS. What the effect on the masonry will be I could not say. While I am a lock-level man, I have not taken the position that there is any structure proposed on the sea-level plan but what if it was honestly built, as it must be, will last for years.

Mr. RICHARDSON. I understood you to say that you preferred and had recommended the lock plan?

Mr. STEVENS. Yes, sir.

Mr. RICHARDSON. It has not yet been determined whether it will be a lock-and-dam or sea-level canal?

Mr. STEVENS. I understand not. That is an unsettled question.

Mr. RICHARDSON. If it should be a sea-level plan, will it affect any calculations you have made for carrying on the lock-and-dam plan?

Mr. STEVENS. Oh, no.

Mr. RICHARDSON. Will you lose any money?

Mr. STEVENS. We have lost some time by not knowing the type, but that would apply to either plan.

Mr. RICHARDSON. You are going along and working upon the lock-and-dam plan?

Mr. STEVENS. Until now, when we are ready to dig, and it would be economy to know what we are to dig. You might ask me to build you a house and I would at once say, "What sort of a house do you want?"

Mr. RICHARDSON. It would alter your plans some?

Mr. STEVENS. Yes, sir.

Mr. RYAN. Have you stated the time it would take to build a lock-and-dam canal?

Mr. STEVENS. Yes, sir.

Mr. RYAN. How long would it take?

Mr. STEVENS. Seven or eight years, I think.

Mr. RYAN. The sea-level canal would take how long?

Mr. STEVENS. I do not know. I have gone on record as saying that it would take not less than fifteen years, and it might take eighteen or twenty years. There are problems there unsolved.

Mr. RYAN. What would be the difference in cost?

Mr. STEVENS. I think \$135,000,000 and \$150,000,000.

Mr. RYAN. The sea-level canal costing the greater amount?

Mr. STEVENS. Yes, sir; that is my opinion.

Mr. ESCH. In making a lock canal, are you taking into account its possible transformation to the sea level?

Mr. STEVENS. Yes, sir.

Mr. ESCH. That would require the laying of the foundations for your locks on the lower level?

Mr. STEVENS. No, sir. It would be so far in the future that I would not do anything of that sort. I would build another lock lower down, then I would take out the Culebra cut and take out 5 feet at a time until I had eliminated it. In that way you could bring about a transformation without costing one dollar. That looks like a paradox, but it is true, as compared with the proposition as now represented.

Now, it is only fair, in discussing this proposition, that the only canal that at all compares with it—namely, Suez—should be considered. But I want to call your attention to the difference in the country through which the two canals pass. The deepest cut in the country through which the Suez Canal passes, for the entire distance of 100 miles, is 90 feet, and that is only for a short distance. There is very little difference in size between the two, but there is an absolute difference in the country; and there is not a stream that flows into the Suez Canal, from one end to the other. It is through a sandy desert. You have an absence of current. There is a little current, but not very much. There is no silt, in consequence of having no streams flowing in, and you have a very fine alignment.

As a matter of fact, the curvature of the canal proposed here at the sea level is four times as crooked as that in the Suez Canal; but the chief engineer of the Suez Canal says that it is very difficult to steer the large ships through the Suez Canal. Now, with a curvature four and a half times that amount and with a current four times, and especially not only longitudinal currents coming together through the length of the canal, but rather coming crosswise from these various points—I am not a sailor, and I only know navigation as I have observed it, and I have not had practice, but it does seem to me absolutely impracticable to put a ship through a canal of that sort, where it seems to me that the wetted section of your ship is more than one-half of the width of the canal, and where you have only a few feet of water under your keel.

I can not conceive how it can be done. I can conceive, by taking time enough with a big ship and putting a tug on each end or side of it, how it can be done, and I believe that it can be done, but under her own steam I do not believe that she would make it. As I came into New York the other day I met one of our large cruiser battle ships, and we passed within a mile of her coming in, and it did look to me, thinking of what I know about the proposed Panama Canal, as though it would be impossible to get one of those tremendous things through there, and it struck me that I would hate to be responsible for the ships which should attempt to navigate that place.

Mr. LOVERING. And yet there is a long stretch where they have to go through now, is there not, to get to the lake?

Mr. STEVENS. Yes; but that is very wide, and has a better alignment.

Mr. LOVERING. On the average would it be 500 feet?

Mr. STEVENS. Yes; we have it all here.

Mr. LOVERING. But the distance from Obispo to Miraflores would be as narrow as under the sea-level type?

Mr. STEVENS. No, sir. We have 200 feet under the lock type, and there it would be under the same plan and dimensions, and everything, as under the sea level. Under the sea level we have a great many more miles. In fact, the canal is to be 300 feet from Gamboa up to Las Cascadas, just here [indicating on map], and then it continues through to near Paraiso, which is here [indicating]. Now, on the lake level is a 200-foot stretch, and on the other it starts here and runs to Miraflores, I believe.

The CHAIRMAN. Will it require more power to propel a vessel at the same velocity through a channel 150 feet wide than a channel, say, ten time wider?

Mr. STEVENS. I should say it would; yes, sir.

The CHAIRMAN. What is the ratio of increasing power in one of these smaller channels?

Mr. STEVENS. I could not tell you that, Colonel. I could not be absolutely certain of what I said; but I say that I think so. I know that piling the water up under the bows of a large ship in a narrow channel like that must necessarily tend to keep her back, and at the same time to render the question of steerageway a very important one.

The CHAIRMAN. And there would be a very great current alongside of a vessel in a narrow channel, would there not—the water rushing back?

Mr. STEVENS. The water, of course, would be piled up in front of the vessel. Practically one-half or one-third of the water has got to get away alongside of the vessel or under her keel, and that is what makes her hard to steer, and it has got to bank up in front and break back. There is nowhere else for it to go. That is why I am opposed to the sea-level canal as it is now proposed. I believe in a sea-level canal if it is a big, fine wide one, as you can build it later on the other proposition.

Mr. LOVERING. I would like to ask you, do you not think that the money cost consideration is the really insuperable objection to the sea-level canal?

Mr. STEVENS. No, sir; I take a great deal of pride in being an American, and—

Mr. LOVERING. I will not say the insuperable objection, but is not the one that you are now considering the strongest?

Mr. STEVENS. No, sir. If the canal could be built for the same money as the lock-level canal, or, to put it the other way, to put it as a business proposition, supposing that I was going into it with my friends, I would take the lock-level canal in preference to the sea-level canal at the same money.

Mr. LOVERING. At the same money?

Mr. STEVENS. Yes.

Mr. LOVERING. And if it cost from fifty to ninety millions more, you would be so much worse off, would you not?

Mr. STEVENS. It would seem so; yes, sir.

Mr. RICHARDSON. Would you propose that the canal should be built by contract or by the Government?

Mr. STEVENS. That is a matter to be settled later. I do not believe in its being intrusted to one party. If you let it in one contract you would have such a monopoly as the world has never seen.

Mr. RICHARDSON. Would it be cheaper?

Mr. STEVENS. That remains to be seen.

Mr. RICHARDSON. It is absolutely so with all Government contracts.

Mr. STEVENS. Yes, sir; it may be.

Mr. LOVERING. I made a calculation here on the estimate that you gave, at about sixteen years, at about \$18,000,000 per annum extended, and compounding it as I go along, I make a cost of \$404,000,000 for the sea-level canal, as against the cost of building a lock-level canal of \$213,000,000, making a difference of \$191,000,000 in favor of the lock-level canal.

Mr. STEVENS. At what rate of interest do you figure it?

Mr. LOVERING. Two per cent in each case.

Mr. STEVENS. Yes. You see, I said that I was conservative in what I stated.

Mr. LOVERING. We are not trying to hold you to anything, of course.

Mr. STEVENS. Yes.

Mr. RYAN. Did you take the French estimate?

Mr. LOVERING. Allowing \$18,000,000 a year, and sixteen years for the sea-level canal, first cost, \$50,000,000; interest for one year, \$1,000,000, and amount paid for work \$18,000,000, making \$69,000,000 expended for the first year.

For the second year the interest on \$69,000,000 plus the \$18,000,000 additional gives you \$88,388,000, and so on in that way, adding the interest at 2 per cent each year, and expending \$18,000,000 a year, it comes on the sixteenth year to \$404,000,000.

Mr. RYAN. That does not include the other \$50,000,000.

Mr. STEVENS. I want to add a little more, in justification of what I have said here.

Mr. LOVERING. Let me finish this.

Mr. STEVENS. Very well.

Mr. LOVERING. That makes, I calculate, an annual charge of \$8,080,000. It makes the annual interest charge on the cost of the lock-level canal, which is \$213,000,000, \$4,260,000—the charges. Are those figures approximately right, in your estimation?

Mr. STEVENS. Yes, sir; I think so. I have made them several times, but I do not recollect them. It has been said that the chief engineer wanted something "cheap and nasty," something that he could build quickly and get the glory. I want to say that I do not care a cent about the glory. There is a lot of hard work in it; and for any man that goes down there and builds that canal there is nothing left after he gets through.

Mr. RICHARDSON. Do you not think there is a heap of glory in it?

Mr. STEVENS. Yes; there may be. But I would not go down there for that. There is some consideration that a man should show for his family and for everything that he has back here. What is it that the other fellow said, "What is the glory when Hannah is a widow?" But I want to say that it is, so far as my judgment goes, not "cheap and nasty" at all. If we could build a true sea-level canal, as people imagine, for \$404,000,000, in ten or twelve years, I would say to build it that way and drop all other plans; but you can not do it. The canal as they have proposed it will cost more, and instead of being \$107,000,000 more it will be nearer \$150,000,000 more, and it can not

be built in eight or ten or twelve years' time unless there is something in the way of excavation and handling of materials developed in the next few years that we do not know at this time; and a lock-level canal will be a better canal, and it will handle the ships more safely, and it will handle tonnage in any size of ship as fast as or faster than the sea-level canal, and it can be maintained in operation for nearly \$2,500,000 a year less. And it can be transformed at any time when the demand comes for it into a true sea-level canal, and there can be saved on the cost of construction and operation at the rate of compounding money enough to build a sea-level canal when the demand comes at no cost whatever, as compared with the present proposition.

Now, I have been criticised, and I have been criticised on the floor of the Senate, for what I said, and I suppose that I am being criticised for being up here instead of being down on the Isthmus. I do not care for that and I do not care what they say. When I am asked my opinion I have got to give it. I would be recreant in my duty if I did not do it.

MR. WANGER. You have been called here and you have made these statements because you have been asked the questions?

MR. STEVENS. Yes; if I came before you gentlemen or before the Senate committee and was asked these questions and I said that I did not know I should be discharged before night, and I ought to be. That is the way I look at it. I do not lose my individuality as an American citizen simply because I happen to be a Government officer, and I do not think that I ought to.

MR. GAINES. You were asked by me which type of canal you thought the proper one, and you did not volunteer your opinion.

MR. STEVENS. No, sir.

MR. ESCH. Have you any suggestions to make on the labor problem?

MR. STEVENS. Do you mean have I any changes to suggest from the method we are pursuing now?

MR. ESCH. Yes.

MR. STEVENS. Yes, sir; I am not satisfied with the labor on the canal and have never been. My idea is that we should not select and use one kind of labor only.

MR. ESCH. What is that?

MR. STEVENS. I think that we should not use one kind of labor. I think that we ought to mix up and get three or four different kinds. Human nature is the same the world over, and when the West India negroes and the Italians and the Japanese and the Swedes find that we are using laborers of only one nationality, we find that we can not do that. We have the matter in our own hands. I would like to have some Chinese, but I understand that it will require legislation to get them.

MR. RICHARDSON. Have you any of the negroes from the South down there as yet?

MR. STEVENS. No, sir.

MR. RICHARDSON. Could you not succeed in getting them?

MR. STEVENS. No; I do not think we could.

MR. WANGER. You would not supplant your entire present force of laborers with Chinese?

Mr. STEVENS. No; not at all. I would supplant a certain number of them. We have something like 20,000 on our rolls down there. You understand that 50 per cent of the blacks are people that we have picked up. That is, we have not brought them there. They have come there. We can let them go at any time. The others we have guaranteed so many days' work, and we shall keep them and return them. We made an experiment some time ago. We got 300 or 400 Spaniards from Cuba, who had been in Cuba on the plantations or working on the railways. They have proven to be excellent men. We pay them about twice what we do the West India negroes, and they do three times the amount of work. They come from the Spanish provinces, and we call them Gallicians.

Now, I have been working two or three months laying plans to get more of them. I do not know whether it has been a success or a failure. I saw a cable from the Isthmus this morning about that. In addition to this, one of my old labor men sailed on the 2d of this month to Madrid to lay the bed plates for getting a number of the Spaniards from there. I do not know what he can do until he gets there.

Mr. RICHARDSON. You have very little labor from the United States?

Mr. STEVENS. We have almost none at all. You spoke of getting the colored men from the South. I do not approve of that. In the first place, the States negro does not mix well with the West Indian negro; they do not get along well together. There is a great deal of jealousy between them. In the second place, I have a pretty intimate knowledge of the South, and I do not think it would be for the advantage of the Southern States to take the negroes away from them. Perhaps you know where there are too many of them. I do not. The South needs all the negroes it has, and more.

Mr. RICHARDSON. The South is getting a great many settlers now. I do not mean immigrants, but they are people coming from the Northern States. I noticed in a railroad report the other day that one railroad has deposited in the State of Alabama a number of families that came from the State of Illinois, and from the Dakotas, and so on out there—from Indiana, some of them—and they had taken up 42,000 acres of land in that State. That is just that one railroad.

Mr. TOWNSEND. Have you any applications from men to work?

Mr. STEVENS. Common labor?

Mr. TOWNSEND. Yes.

Mr. STEVENS. No, sir. You are simply robbing Peter to pay Paul, Mr. Richardson, if you take the laborers from the Southern States to work on the canal.

Mr. RICHARDSON. Yes; but really the South is getting another kind of labor of late. The negro will not mix with the Italians, and we do not want them mixed down South at all.

Mr. STEVENS. The Jamaican does not make a very good teamster, and the sanitary department wanted some teamsters, and they sent to New Orleans and picked up about 90 of them, and I said immediately, "You will not have one of them in sixty days." They had a few of them left, but they nearly all disappeared. They did not like it, and they went back, or went away.

Mr. LOVERING. How many hours do they work?

Mr. STEVENS. Eight hours.

Mr. LOVERING. Eight hours in twenty-four?

Mr. STEVENS. Yes.

Mr. RICHARDSON. I should say that our southern negroes were without any value there.

Mr. STEVENS. Yes; I think if they are of any value they are of value right where they are.

Mr. ESCH. Have you tried the Japanese on the Isthmus?

Mr. STEVENS. No, sir.

Mr. ESCH. The exclusion law would not prevent your using them?

Mr. STEVENS. I understand so.

Mr. ESCH. Have they not been found of use in the Tropics elsewhere?

Mr. STEVENS. I do not know anything about the Japanese in the Tropics. The Chinese have been used in the Tropics, and of course you take a great extent of the country back from the coast in China, and there are millions of them living and working there in a climate which is almost identical with that of the Isthmus of Panama. There is a prejudice about them, of course. But I know that when they were building the Panama Railroad they used them with great advantage. At the time they were building the Panama Railroad, of course, they had what is called the "Chagres fever," and they died in great numbers from it. Now, I have seen the Chagres fever, and I know what it is. At that time on the Isthmus they had no provisions to take care of them, and the Chinese commenced dying very rapidly, and they commenced committing suicide. The name of the place, Matachin, I understand, means "Dead Chinaman." There were 400 of them committed suicide there.

Mr. RYAN. They would lie down and let the trains run over them?

Mr. STEVENS. Yes; and they committed hara-kiri, great numbers of them. I have no doubt that under the sanitary conditions which now prevail there they would be all right. I have had at one time 4,800 working under me, in the Selkirk and coast-range mountains. When we were building the railroad we had large numbers of them. Of course they would not do as much work as the average northern white man, the Swede, or the Irishman, but to me they were of more value at a dollar a day than the white man was at \$2. And you never saw a more cleanly people. These poor fellows would work all day at their hard labor and then come back at night and hang up their little basins of fish and rice to cook, and then every one of them would take his clean clothes and go down to the little mountain stream, bathe, and change every rag of clothes that he had on before he would eat his supper.

Mr. ESCH. Do you care to make any observations as to how the work should be done, whether by the Government or by contract?

Mr. STEVENS. I would divide it into subdivisions, and I would never think of letting it to one party. I do not think that is possible. There are some very grave features connected with contracting at all, but I think that it can be done. It would depend altogether on the bids that I would get. I could tell better afterwards, when I knew what the work would cost. Grave questions would be involved in this. It is absolutely necessary not only for the United States to retain control of the policing and the government, but also sanitation; and sanitation means something more than the rules that the board of health promulgates in a city. It means the

personal inspection two or three times a day of every laborer's house on that Isthmus.

Perhaps you think the estimate of the sanitary department is high; but it is necessary. I do not suppose that four hours ever goes by but what some man connected with the sanitary department goes through every laborer's quarters on the Isthmus. We do not allow a thing to collect around those houses or in them. We do not allow a pile of dirty clothing to collect under a bunk or anything. And by means of that expenditure of money and that close inspection Doctor Gorgas has been able to get the record that we have, which is something remarkable. To-day our sick list is not any more than it is in the northern cities. Last August and September, eliminating the yellow fever and taking simply the other fevers and pneumonia and bowel troubles and everything of that sort, even down to child-birth, if you will, and broken limbs, in my department I have got only 40 per cent in the hospital to-day of what I had a year ago. That shows the difference.

Mr. RICHARDSON. That is a very great change.

Mr. STEVENS. It is a great change. And to-day and for the last few months the greatest cause of mortality there you would never guess unless you looked it up. It is pneumonia.

Mr. RICHARDSON. In that climate? Pneumonia?

Mr. STEVENS. Yes, sir; pneumonia.

Mr. RICHARDSON. I am surprised to hear that.

Mr. GAINES. Do you have cold nights?

Mr. STEVENS. We would not call them cold. They are a great deal colder than here during the heated term.

Mr. RICHARDSON. It must be a very humid atmosphere.

Mr. STEVENS. Yes; it is. But the great difficulty to be overcome there in the way of sanitation is not yellow fever. Yellow fever is a by-product. The effect of the yellow fever is on the mind. It scares people. The great difficulty is malaria.

Mr. WANGER. Have you any hope of banishing malaria?

Mr. STEVENS. No, sir; I do not think so, but it can be very largely decreased.

Mr. ESCH. Then one objection that you would have to letting the work out by contract would be that you could not control the sanitation?

Mr. STEVENS. You would not have to, no matter whether you let a small or a large contract. You could not trust the contractors to do it. They would not spend the money. Then the Panama Railroad is a creature of the Government of the United States, and while you are taking care of the commercial business and must always take care of the commercial business, the utility of that railroad is largely for the building of the Panama Canal. In other words, it is an incident to and must be used for the building of the Panama Canal, and whether or not the contractor or a set of contractors can take hold of that and handle the railroad and run the business or not is a question, or whether the Government would have to handle the contracts at so much a train or so much a load, or to let the contract material run over the road at so much a mile is a question, and all that must be considered.

Then we must have very large machine shops that can take care of all the necessary repairs. We have 100 or 120 engines, and the

contractor would not duplicate that plant, and how would those repairs be handled? Those are problems to be considered; but, on the other hand, it must be recollected that the dollar of the Government should go as far as the dollar of the contractor, and somebody must supervise this, and the Government goes into the market and hires an engineer, and it is simply a question of whether we get down to a business basis and eliminate all other outside influences and recognize that that must be done as a business proposition, or whether we have got to travel along and have every Tom, Dick, and Harry say, "Here, you are doing this wrong." Although I have not been interfered with very much, there have been times when I would have been glad to come back here.

Mr. WANGER. The charge has been made that the work was being hampered by political favoritism. Have you seen any evidences of any such thing?

Mr. STEVENS. No, sir; I have not. I have 12,000 men on my pay roll, blacks and whites, and if there is one of these 12,000 that holds his position by birth or influence or who got it that way I do not know it. I would not discharge him if he had, if he filled his place, but I would not keep him an hour if he did not. I have not hired anybody because there was pressure on me; and there has been no case of pressure, and there have been very few cases where I have been even asked to appoint a man.

Mr. ESCH. Could not the work be prosecuted much cheaper if you did not pay any attention to the eight-hour law?

Mr. STEVENS. Yes, sir; I think so. Of course by a rider to the appropriation bill we have now a right to work aliens more than eight hours, but we can not do it for this reason: Ninety-five per cent of our superintendents, of our engineers, of our general foremen, are whites, and American citizens, and it is doubly impossible to work a gang of negroes ten hours and then let your superintendent go at the end of eight hours. The negroes do not do very much work when the bosses are over them, and they would not do any at all if they were not.

Mr. WANGER. Where do your mechanics come from?

Mr. STEVENS. Our mechanics come from the United States almost altogether, and we are getting a good grade of mechanics. The change in the last few months has been very remarkable.

Mr. WANGER. There has been a great deal of money expended in cutting off the growth of vegetation?

Mr. STEVENS. Yes.

Mr. WANGER. Is there any way, by grazing, to avoid it?

Mr. STEVENS. Yes; I think so. I think around the settlements like Empire and Gatun that sheep and goats would help out very much in keeping down the growth of grass. It has been suggested often, but the sanitary people have not got around to trying it.

Mr. WANGER. There has not been any experiment made so far?

Mr. STEVENS. No, sir. Something was said here this morning about the prevalence of mosquitoes. There are in certain places many mosquitoes, but the Isthmus of Panama is not what I should call a very prolific mosquito country as compared with many parts of the United States, judging from my many years of experience here.

Very seldom there is a day goes by that I am not out on the work, particularly since I have been located at Culebra. I go all over the work almost every day. In other words, I am out at all times in the day from 6.30 in the morning up to night; but I do not go out at night, and my house is screened, as every one of the houses of whites is on the Isthmus, and as everyone of the houses of the blacks will be. I live in a wooden house, and I have the same amount of protection, no more and no less. I have never seen one-tenth part of the number of mosquitoes on the Isthmus that I have seen elsewhere. But the strangest part of it is that I have never been bitten by a mosquito.

Mr. WANGER. Have you been down to the old church; I do not mean the large one, but the old church?

Mr. STEVENS. I have never been there.

Mr. WANGER. There was a perfect swarm of mosquitoes there.

Mr. STEVENS. Since I have been at Culebra I have seen two mosquitoes; that is all. I live up on the hill where the men are quartered.

Mr. ADAMSON. How far is the place where Balboa first sighted the Pacific Ocean, from Colon?

Mr. STEVENS. I do not know. Some put it at Darien, and others at Colon. If he landed at Porto Bello he must have gotten his first view from the high mountains, about 6 miles east of Panama.

Mr. ESCH. How many men do you expect to employ at one time on the canal?

Mr. STEVENS. It depends altogether on the kind of men. If you figure on those that I have got now, the West Indian blacks, I think on our pay rolls we would have from 30,000 to 35,000. That means an effective force of about 20,000.

Mr. ESCH. You have 20,000 now.

Mr. STEVENS. We have 23,000 names on the rolls now, and that means that on the work there are about 15,000. These men do not work constantly. They work for two or three days in the week and get enough to buy what little food and necessities they want, and then they lay off. They have no ambition, in which they are probably nearer right than we are—at least they are happier. But there is hardly a ship that goes down now that is not crowded and does not carry a great many women and children, and that means that our mechanics and train men and the better class of men are going there to stay. And that means that we are getting something besides a floating element.

Mr. TOWNSEND. I was interested this morning in your statement about the change of the location, as proposed by the majority and minority reports. Now, your plan, as I understand you, was to follow the line of the old French canal?

Mr. STEVENS. You are speaking now of the southern end?

Mr. TOWNSEND. Yes.

Mr. STEVENS. Yes; that was my own idea.

Mr. TOWNSEND. And did I understand you—you did not say that, but did I understand you to say or to mean—that the work which the French company did there would fully offset the extra length of the canal in going that way around?

Mr. STEVENS. Yes; in my opinion. And there were other advantages where I differed from the minority board and from the Commission. I think that you will find that I am on record in regard to that in the report of the Commission, in which I said, however, as

between the lock canal and the sea-level canal, that I was willing to waive my objections on the ground of the extra expense. Here is my idea: Here are the four inside islands right here [indicating], and the United States Government owns all but a part of one of them. In a direct line from those islands a ship can lay up behind them, and there is no possible way—and I have experimented by going out and laying around in a launch—there is no place in which you can fortify so that a ship can be dislodged from that place unless by dropping shells on her from above from land batteries from a distance of 3 or 4 miles.

Now, if the canal is to be made neutral, I do not believe there is any way of protecting the canal if you leave that situation in that way, a ship being supposed to lie right here [indicating]; and I said that the importance of that was great enough to justify the expenditure of four or five million dollars, and to put these locks at Pedro Miguel, and then you would be 4 or 5 miles from where a ship could lie; and the only way that she could throw a shell on the locks there would be that you might, with a range finder, after many experiments, get a shot over at those locks. But here they are in plain view. The Secretary agreed with me that it would be better to put one lock at Pedro Miguel and two here [indicating on map]. I would put the locks through over the old French alignment up to Pedro Miguel.

Now, it is said, "You are arguing against your own mosquito theory." But in the interior there is no material difference between the old sea level and the other, so far as that is concerned. Throwing the difference of the additional depth out of the question, look at the map. I do not think that anybody is going to claim that there is any chance of any large population ever being in here [indicating on map]. Four hundred years have gone by, and there is not a white settler in there as yet, except at Gatun and Mindi. But throwing that aside, just cast your eye over that [indicating]. Here is an artificial fresh-water lake, and here is another one, and here is another one [indicating], and I do not believe that there is 10 per cent of difference in the area to throw out this little lake here [indicating]. If the lock type of canal will breed mosquitos, so will the other.

The great concentration of population, both black and particularly white, will always be at Panama. It always has been. It is the natural place for a city. Suppose we go to work and create a fresh-water lake right there [indicating]. Now, if there is any chance to breed mosquitoes it is right there.

Mr. WANGER. On the other hand, will there not be a great deal of apprehension on the part of the inhabitants of Panama that they may be inundated by a breaking of the dam?

Mr. STEVENS. Yes; but that would be totally unwarranted.

Mr. WANGER. But do you not think that there would be a great deal of apprehension while the works are in process of erection?

Mr. STEVENS. Yes; I suppose so. On this lake from this 4 miles or so of the free navigation you do not get the advantage that you do in the long unobstructed navigation here. But as I said, I would be willing to waive that, although I think the other plan is better. By following the old French line up here we preserve the railroad terminals also in their entirety, and can add to them as we like; and there must, and always will be, terminals after the canal is built, although, of course, small ones.

Mr. WANGER. And if the lake was constructed, you would have to build new terminals?

Mr. STEVENS. Yes.

Mr. ESCH. How much need would there be for the railroad after the canal was in operation?

Mr. STEVENS. I can not see very much.

Mr. ESCH. Would there be enough to change its location almost half way across the Isthmus for you to have this bigger lake?

Mr. STEVENS. Yes, because there would be to here that you would be covering the railroad, and you must have the use of the railroad for a year or a year and a half while constructing the canal. I would build a cheap railroad. I do not see any great amount of use for the Panama railroad after it is built. There will be some timber products going out of the country and there may be some mines in there, although they have not had any as yet. I have had in mind an electric line. But nobody is going to unload stuff that is going across from one place to the other and bring it over here and then load it up again. Of course, that is ridiculous.

Mr. WANGER. The lock type of canal would require a very large embankment, would it not?

Mr. STEVENS. Yes; crossing these places in here [indicating on map], and one or two places in here [indicating].

Mr. TOWNSEND. How long do you estimate it would take for a boat to make the trip across there, if you had the locks?

Mr. STEVENS. It should be made in ten hours. I take the opinion of Mr. Ripley and Mr. Noble, who are the best authorities in the world on locks. There is no question about it.

Mr. WANGER. You accept the plan that they submitted to the Board of Engineers?

Mr. STEVENS. Yes. I have already retained Mr. Ripley's services for the general design and construction of those locks, because I think that he knows more about it than I do or anybody else.

Mr. WANGER. The Panama water supply is obtained from Lake Culebra, is it not?

Mr. STEVENS. From Rio Grande Lake, right there, that little blue spot [indicating on map].

Mr. WANGER. Culebra station?

Mr. STEVENS. Yes; a mile and a half south.

Mr. WANGER. And either type of canal crosses the main, does it not?

Mr. STEVENS. Yes; at Pedro Miguel.

Mr. WANGER. That would be destroyed, would it?

Mr. STEVENS. No, sir; we would have to substitute; we would have to put a syphon under the canal to take the water across.

Mr. TOWNSEND. The water main has been completed and is in operation?

Mr. STEVENS. Yes; water was turned in there on the 4th of January last.

Mr. TOWNSEND. I remember that they were working on that when we were there.

Mr. STEVENS. Yes; and we have a very nice supply, and to show you the quantity, the entire reservoir was only drawn down a little more than 4 feet during the dry season, and I had an estimate at

the end of the dry season, and there was enough, at the same rate of increase, for an entire year more.

Mr. TOWNSEND. Does not that water, held in such an amount by the reservoirs, get stagnant?

Mr. STEVENS. In the dry season, as in all reservoirs in the world, a growth of algæ will occur; but there is no bad taste to it.

The CHAIRMAN. What was your observation as to the value that they have given in Panama to an abundance of good water, as to the quantity that they use?

Mr. STEVENS. It took them some time to appreciate it. Of course the house connections are not all made. We had taps put on, little faucets put on the hydrants, so that they would go there and draw water at the street corners. Previous to this time there were a large number of the old wells, which had been there a couple of hundred years and must have been very foul, and the water carts would haul the water around town and sell it. We gave them water from the taps, and I have seen a native woman take her bucket and her money in her hand and go right past one of these hydrants and go and buy water from a water cart that came from these old wells.

Mr. TOWNSEND. Is not it colder?

Mr. STEVENS. No, sir; I do not know that it is. It takes about that long to get an idea through them. But they have now filled up a large part of all these old wells, and now they are universally getting the water out of the pipes and the hydrants, and they use it in very much larger quantities than before. In fact, they are running sprinkling carts in Panama. No restriction is put on the use of water in Panama. In fact, we encourage their use of it.

Mr. WANGER. The charge is published that in excavating a sewer ditch it was necessary to go 20 or more feet—I do not remember exactly how far—and the sewer could have been dug to a width of 2 feet if there had been boards supplied for shoring the banks, and there was an abundant supply of boards, but that red tape prevented their being furnished; and that an engineer suggested finally that the ditch should be dug so wide that the banks would not cave in, and consequently there were 87,000 yards of needless excavation at an expense of \$1 per yard to the United States on account of these red-tape methods. Do you know anything about that?

Mr. STEVENS. No, sir; but I would say this: In the first place, the character of the material in Panama is such that this story does not apply. The material is indurated all through. In the second place, there is not a ditch or an excavation in the sewer system there that I have not personally inspected as it was being constructed, and I have never seen a ditch slip. Finally, there was no red tape about a man going and getting lumber, and there was no difficulty in his doing so in half an hour if he wanted it. The office is never more than half a mile from the scene of the work, and all that a man had to do was to go to the office and make his requisition and have it approved and go and get a team to haul it; and that was all there was to it. Talk about red tape in getting supplies; there is nothing to it. And as far as the expenditure of \$87,000 in the digging of that ditch is concerned, that is absolutely false. I do not think that a ditch, to my knowledge—and I say that I have seen them all—has ever been dug there over 4 feet wide. I do not recall any such case.

Those statements are on a par with those made along the same line, and there is about as much truth in one as in any other. I have seen a statement in a California paper to the effect that the chief engineer was well because he was in a brass cage at a thousand feet elevation. As a matter of fact, I live at an elevation of 400 feet above the level of the sea, in an ordinary wooden house, with screens on it, and I go out every single day from morning until night. Those statements are all made for a purpose.

Mr. WANGER. You are at Culebra?

Mr. STEVENS. Yes.

Mr. WANGER. What force have you there?

Mr. STEVENS. In Panama we have an office, and all the rest of the force is taken off.

Mr. WANGER. Where is that quartered?

Mr. STEVENS. At Culebra.

Mr. WANGER. Who lives in the house that was the chief engineer's house there?

Mr. STEVENS. The American legation has that house; the American minister has it. The lower floor is not used by him.

Mr. WANGER. The French had their offices up on the second floor?

Mr. STEVENS. Yes; that is practically closed. The second floor is occupied by the American legation, and on the third floor there are four or five sleeping rooms that are used by transients, people that come in there that have to be taken care of. We have those floaters that we have to take care of from time to time.

Mr. WANGER. Did I understand you to say that the American minister lived there?

Mr. STEVENS. They have their offices there. Governor Magoon lives in the house that he used to live in. I would not live in the old engineers' house a minute. You can not get me to live in Panama.

Mr. WANGER. There was a plan for the dam at Alhajuela, and then there was another project?

Mr. STEVENS. Yes; then there were several other projects to drive tunnels through to the north of the Chagres River to the Caribbean Sea. One comprises a cut 12 miles long, which never could have been built. Then there were two short tunnels there, I think. That proved not to be at all practical, and then they dropped back on building the Gamboa dam.

Mr. ESCH. Can you imagine anything ever shutting off the water supply for operating that canal?

Mr. STEVENS. Only if the Lord should suspend rains. If we should have two years or even one year of suspended rain then you would not have water enough. But we had this last year as near a drought as ever before has happened, according to the records. We have the records for the last twenty-five years, and there was less rain this last year than ever before in that time.

Mr. ESCH. The average rainfall is about 25 inches?

Mr. STEVENS. Up around Bohio I think the record is 146 or 150 inches. It is a trifle less at Colon. There is no probability of not having water for the operation of the canal unless the changes in the seasons are such as have never been known. The rainy season comes in the first of May and the rains continue until the first part of December.

Mr. ESCH. Is it not possible by the use of spillways at Gamboa dam to entirely divert the flow of surplus waters into the canal at the sea level?

Mr. STEVENS. Yes; they figure that they can take out 15,000 cubic feet per second and let it into the canal there. They can probably take care of that in that way, but, at the same time, it is admitted that the addition of this would produce a decided effect in the Chagres after you leave the mouth of the Trinidad. That brings up a point that I would like to call your attention to. In the first place, during the construction it is proposed to build a parallel canal from the Gamboa dam along the line of the foothills down here [indicating on map]. I do not know how far it is to go, but I imagine clear through to Bohio. That is to take the waters of the Chagres while the canal is under construction. After construction that is to be abandoned and the water is to go directly into the canal.

Now, these lakes here [indicating] are artificial basins. You can see them here [indicating on map]. The current of these rivers is to be reversed. In other words, to speak in a countrified way, they would run uphill. They are to build a dam here and another one there, and there is another one here, and another one here somewhere [indicating]. I think there are four of them. They are going to bank that water high enough so that it will run down here into the Trinidad [indicating on map]. Now, in three different cases that involves the construction of dams, and I understand from the description that they are earth dams of exactly the same construction as at Gatun. Nothing whatever is known as to the location of these dams. There never have been any engineers there, and there never has been any survey except for the very fanciful map made by the French engineers. They have guessed at the course of the rivers and the elevations. They have taken narrow places in the map and said: "We will put a dam there."

Nothing has been known about the foundation for those dams. It may be all mud. Those dams hold back 75 feet of water. I have been calling those dams to your attention. If those dams went out, of course the entire lakes would be precipitated into the canal. I do not know if they can not be built and can not be made to stay. Nobody knows anything about it. There has never been an engineer of the Commission or any member of the Consulting Board within 2 miles of it for purposes of examination.

Mr. TOWNSEND. Now, which plan will affect the disposition of your earth most generally?

Mr. STEVENS. If we build the Gatun dam, we will put a number of millions of yards of earth in there [indicating on map]. To build the dam at Ancon, if we build a sea-level canal, we have got to get places where the country is flat enough so that the material will not be washed back into the canal. With the lake way I would come down here [indicating on map] and select a point away from the channel half a mile or a mile, where I would deposit material that would be covered by the deep indentations of the lake afterwards.

Mr. TOWNSEND. I did not know but the forming of an artificial lake might occupy some of the land that you might otherwise use as a dumping ground.

Mr. STEVENS. You understand that the topography governs the place. In other words you would not put this stuff on sloping

ground, because it would find its way back into the canal. But you can put it back in the indentations of the lakes, where it is perfectly flat, with safety. You want to remember that the river Chagres is perfectly level from Colon to Bohio. In other words, the tide rises and falls within two or three inches as much at Bohio as at Colon. From Bohio the country commences to rise until when you get to Gamboa it is 50 feet; the bed of the river is 50 feet above sea level. At Gamboa, from mile 17 to mile 31, in that distance the river rises 14 feet. The sea-level canal means exactly what it says, that it has got to be dug level, and when it comes to Gamboa the surface of the sea-level canal will be 50 feet below the bed of the Chagres at this point, and correspondingly less at Bohio, where it corresponds, naturally. That means that these smaller streams coming in would fall into the sea-level canal from a height of from 10 to 163 feet. In other words, there would be cascades that must be taken care of. Of course large bodies of water, some of them amounting to 1,000 feet per second, can not be allowed to come into the canal with any such head as that. They would fill the canal up in twenty-four hours. The project is to bring them in in pipes into the canal. I do not think that would be practicable, because the amount of trash that would be carried down by these streams would fill up an iron pipe in two minutes. The other project is to form a large number of long steps, like the steps of the Capitol here, so that the water can dash down and be broken as it runs down the steps. That could be done easily; but where the water debouches into the canal is the place where it will deposit all that silt, and my opinion is that you would have to have a lot of dredges working all the time cleaning out the canal. It has been said that you could dig basins for this purpose, but of course, those basins would be simply big bowls and they would have to be dredged out. I think they are a disadvantage, because you can let the stuff come right into the canal and dredge it out there cheaper than you can take it out of the basins.

Mr. WANGER. Are they not going to have it just the same with the lock canal after they get it built?

Mr. STEVENS. No; there is no stream coming in until you get to the Culebra cut. This big stream runs up 36 miles before you get to the 80-foot level [indicating on map]. This is something like 14 miles up [indicating]. All your silt in these big rivers would deposit 14 miles back from the canal, and these streams grow smaller, and you can see the distance they are apart. Here is 3 miles, there is 2 miles [indicating] that these streams come in.

Mr. WANGER. Under the lock canal the streams coming in strike the large body of dead water, and the force of the current is broken?

Mr. STEVENS. That is the theory.

Mr. WANGER. And under the sea-level canal you would either have cross currents or you would have to make the channel parallel with the line of the canal?

Mr. STEVENS. I think it would result in building three canals, one to take the traffic and one on each side to take the water. I think you would absolutely have to keep the majority of that water out of the canal or you would find that you would have a head current that you could not navigate with large ships. The other reason is that you would have to keep it out of there on account of the large amount of silt that it would bring in. You would have only 3 or 4 feet of water

under your keel there, and it is very easy to fill that up. The third reason is the cross currents.

Mr. ESCH. Does not the sea-level canal project at present contemplate diversion?

Mr. STEVENS. Yes; I have just explained the diversion back from the ridges here [indicating]. They contemplate taking the Mindi and the Gatun out. But what I say is that you must either do one thing or the other, either let those smaller streams come in or dig canals at each side of the traffic canal and keep it out until you take it down here and get rid of it through the Gatun or the Mindi. That is my opinion. It may not be worth much, but I believe I am right.

Mr. WANGER. Under the lock plan you would have to make some provision for the mouth of the Obispo.

Mr. STEVENS. Exactly, and of the—

Mr. WANGER. As I understand, you propose to build a dike?

Mr. STEVENS. Suppose that is the railroad, and it runs right around that point [indicating on map]. The only dike that could be built in the lock plan is here [indicating]. There has got to be a little dike there.

Mr. WANGER. That is at Paraiso?

Mr. STEVENS. Yes; the railroad comes down here and crosses there and comes down here [indicating]. I have got to put a dike in there 25 or 30 feet high. That is the only dike that is to be put in there. The Trinidad comes down from the west and cuts off the entire drainage here [indicating]. This water must be kept out of the sea-level canal. It is a tremendous large river, and it is expected to do that by diking from the Agua Clara Marsh—from this vicinity down here [indicating on map].

Mr. WANGER. Is that river subject to overflows?

Mr. STEVENS. Yes.

Mr. ESCH. Not so much as the Chagres?

Mr. STEVENS. No; and for this reason, because you go up here 36 miles before you get 88 feet of elevation. Then it rises very rapidly. Of course, in the upper reaches of the Trinidad the river rises very rapidly. You get very violent raises there, but it is checked up long before it gets to the Chagres. You get a great body of water, but it comes slowly, whereas the Chagres comes right down through; and that is the reason it is so destructive at Gamboa.

Mr. ESCH. One of the arguments made against the lock-level type was the large number of acres submerged and the cost of purchasing that land.

Mr. STEVENS. Yes.

Mr. ESCH. Now, if we take the sea-level canal with the four dams you mentioned, would that combined area almost equal the area of the lock-level type?

Mr. STEVENS. No, sir; I do not think more than two-thirds of the area would be covered by those two lakes here [indicating on map]. The argument has been made in many places that the cost would be millions of dollars for this land. That argument is based on the fact that the Commission condemned some land in Panama for which they paid \$41,000; ergo, the cost of the land in the interior that they require would be the same per unit. The land required lies between Ancon Hill and the city of Panama. Panama is on an

island, surrounded on three sides by water, and on the other side by the manglares. That is a marsh covered at high tide. Those lands always belonged to Panama, and their right was transferred to us.

Now, the city of Panama is solidly built and there is hardly room for another house in the town proper, and there is no possibly way for Panama to expand, excepting into the sea or a very small way into this manglare or onto the Santa Rosa tract. In other words, this tract which the Government acquired and paid \$41,000 for covers two-thirds of all the available area that there is left for Panama to expand in, and Panama is built solidly up to it, which means that it is highest-priced business or residence property. Now, it is just as fair to assume that land on Pennsylvania avenue as a unit of price should be compared with the poorest kind of land you could find over in Maryland or Virginia; in other words, if I go out on Pennsylvania avenue and pay \$80,000 for one-third of an acre, that I should pay \$80,000 or \$90,000 for the same amount of unimproved farm land out in Maryland or in Virginia. This land is a jungle all up through here, which would be acquired for the purpose of the canal. It is of no use. There is not a road on the Isthmus of Panama except the streets in Panama and 5 or 6 miles that the Commission has built between La Boca and Panama and out to the Zone line.

Mr. ESCH. Across the savanna?

Mr. STEVENS. Yes. The present charter of the Panama Railroad, which was gotten fifty or sixty years ago, contained a clause prohibiting anybody from building a road in any direction on the Isthmus, and the old owners of the Panama Railroad strictly enforced that. Their idea was to prevent railroads being built that might take some of the business from the railroad.

Mr. ESCH. They used to charge people for walking on the track, did they not?

Mr. STEVENS. Yes; they used to charge people for walking on the track; that is right. And if you except the streets of the town there is not to exceed 8 or 9 miles of wagon road on the Isthmus of Panama. The only thing that approached a wagon road was the old hack trail to Old Panama, which was disused for many, many years. That was the way that they brought their pelf to Panama and packed it across to Nombre de Dios, an old Spanish town, and from there shipped it to Spain. The road was about 6 feet wide, and paved, I understand, the entire length with cobblestones. It is in use in parts now. I have seen it in places. That was the road where, under Queen Elizabeth, the English used to come out and waylay the Spaniards as they were coming across.

Mr. ESCH. Could you develop power from the Gamboa dam for the purpose of excavation or motive power?

Mr. STEVENS. I hardly think so. In the first place, it would be several years before you could do that. No; I do not think it would pay. I think this, though; later on you can develop from Alhajuela by a low dam, or at some other favorable point you could develop plenty of power to operate your final railroad, which, as I said before, I think, would be made an electric line.

Mr. ESCH. Is it contemplated to light the canal electrically?

Mr. STEVENS. I would like to have some parts of it lighted which I can work at night. Do you mean before or after completion?

Mr. ESCH. Before and after.

Mr. STEVENS. Of course, after it is completed it has got to be lighted some way.

Mr. ESCH. How about going through the Culebra cut?

Mr. STEVENS. You would have to light the sides of that, of course.

Mr. ESCH. And the approaches to the locks?

Mr. STEVENS. Yes.

Mr. ESCH. All approaches to locks?

Mr. STEVENS. Yes. That would be taken care of, and it is estimated that in the Gatun locks ample horsepower for operating the machinery and the lights would be necessary.

Mr. WANGER. In the Gatun lakes you would get, without any great amount of excavation, a good wide canal channel that would eliminate more than a mile of length?

Mr. STEVENS. By coming so near what is known as Lion Hill cut-off, with that depth of water. It will probably take me until August to finish all the detailed surveys in that part of the country. It is expected that with very little expense we can get a wide channel—not less than 600 or 800 feet wide, probably—that will cut off a little over a mile. But on the map we have not taken that into account. We have simply taken the known longer line.

Mr. WANGER. The same thing might be possible in the neighborhood of San Pablo?

Mr. STEVENS. Yes; there is a slight diversion there that is possible to be made, but I do not believe in that.

Mr. WANGER. You think there would be too much excavation?

Mr. STEVENS. Yes; I think so.

Mr. TOWNSEND. Do you operate your men down there under the civil-service rules?

Mr. STEVENS. Yes; that is, the inside force; the clerks are all under the civil-service act. The others—the outside men—are not.

Mr. TOWNSEND. Are they subject to a physical examination—the inside men?

Mr. STEVENS. A physical examination?

Mr. ESCH. Yes.

Mr. STEVENS. The same examination as all the civil-service people are subjected to.

Mr. ESCH. I did not know whether you had any special examination for that particular locality.

Mr. STEVENS. No.

Mr. RYAN. But they are examined specially for the Panama Canal service?

Mr. STEVENS. Yes.

Mr. RYAN. That is a separate examination from that for the Departments in Washington?

Mr. STEVENS. Yes. If we want a clerk we call on the Civil Service Commission for that clerk, just as we would for a clerk in the Treasury Department.

Mr. RYAN. I did not think they were on the same list.

Mr. TOWNSEND. Do you have a right to promote a man if you see fit?

Mr. STEVENS. Without the civil service?

Mr. TOWNSEND. Do you have a right to promote a man?

Mr. STEVENS. There are three classes of clerks—first, second, and third. We can promote from one to another, but we have no right to take from one class and put into another. We have to make application to the Civil Service, and they have to take an examination. Mr. Cooley now is arranging for a board on the Isthmus as an appendix to his office. Of course outside men I can handle as I please.

Mr. WANGER. Are you hampered at all by the rules?

Mr. STEVENS. Not at all. I was hampered when the entire force was under the civil service. They were not able to furnish artisans and mechanics and people of that sort, and last winter when I was up here we went over the whole matter, and it was decided in that way—that we would take care of the outside men, so as to leave the inside portion of the force under the civil service.

Mr. WANGER. What portion of the time does the committee live on the Isthmus?

Mr. STEVENS. I could not tell you about the proportion.

Mr. WANGER. Governor Magoon is living there, is he not?

Mr. STEVENS. He lives there all the time, and the balance of the Commission have paid one or two visits. Mr. Shonts has paid three visits.

The CHAIRMAN. If there are no further inquiries, we will consider the committee adjourned. Is there anything that you desire to say further?

Mr. STEVENS. Nothing, Colonel; excepting if the gentlemen want to ask some more questions I will be very glad to answer them.

Mr. TOWNSEND. You have great faith that this canal can be constructed in the lifetime of some of the people who are now in existence?

Mr. STEVENS. If I did not have, I would never go back there. Oh, yes; I know it can. There is only one absolute essential, and that is that we retain our grip on the sanitary situation. The other questions, while they are difficult, can be handled all right. And as far as the yellow fever is concerned, we may occasionally have a sporadic case, but I think that the yellow fever will come in from the outside if we get it. In other words, it is a matter of quarantine.

Mr. WANGER. When is the election to occur in Panama?

Mr. STEVENS. The 1st of July, I believe.

Mr. WANGER. Does Governor Melendez come up for reelection, or is his office involved in this election?

Mr. STEVENS. I do not think his office is involved. Even the President is not, you know. President Amidor holds over.

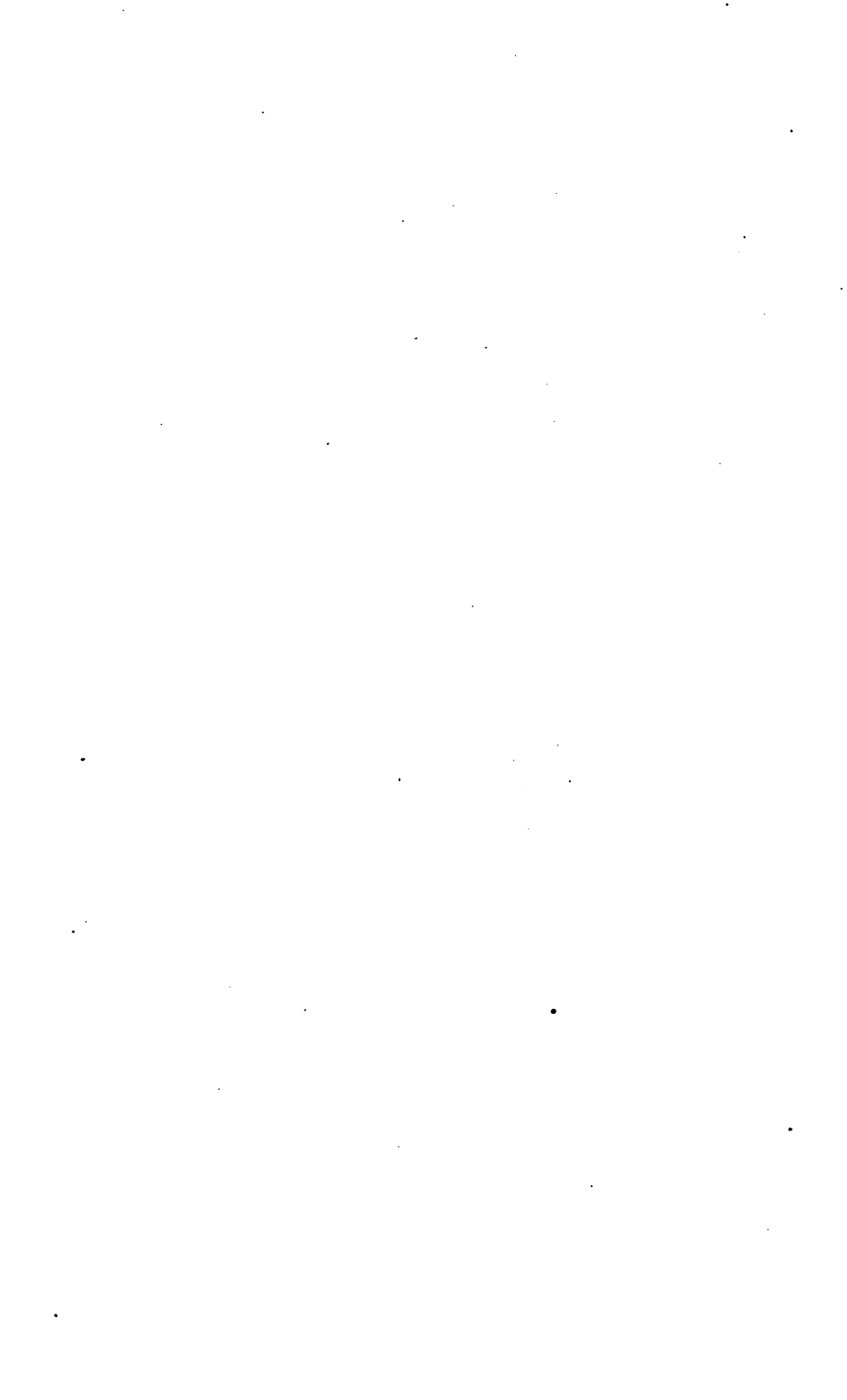
Mr. WANGER. It is the members of the Parliament?

Mr. STEVENS. Yes; the members of the Parliament.

Mr. WANGER. Well, the committee is very much obliged to you, Mr. Stevens.

[Adjourned.]

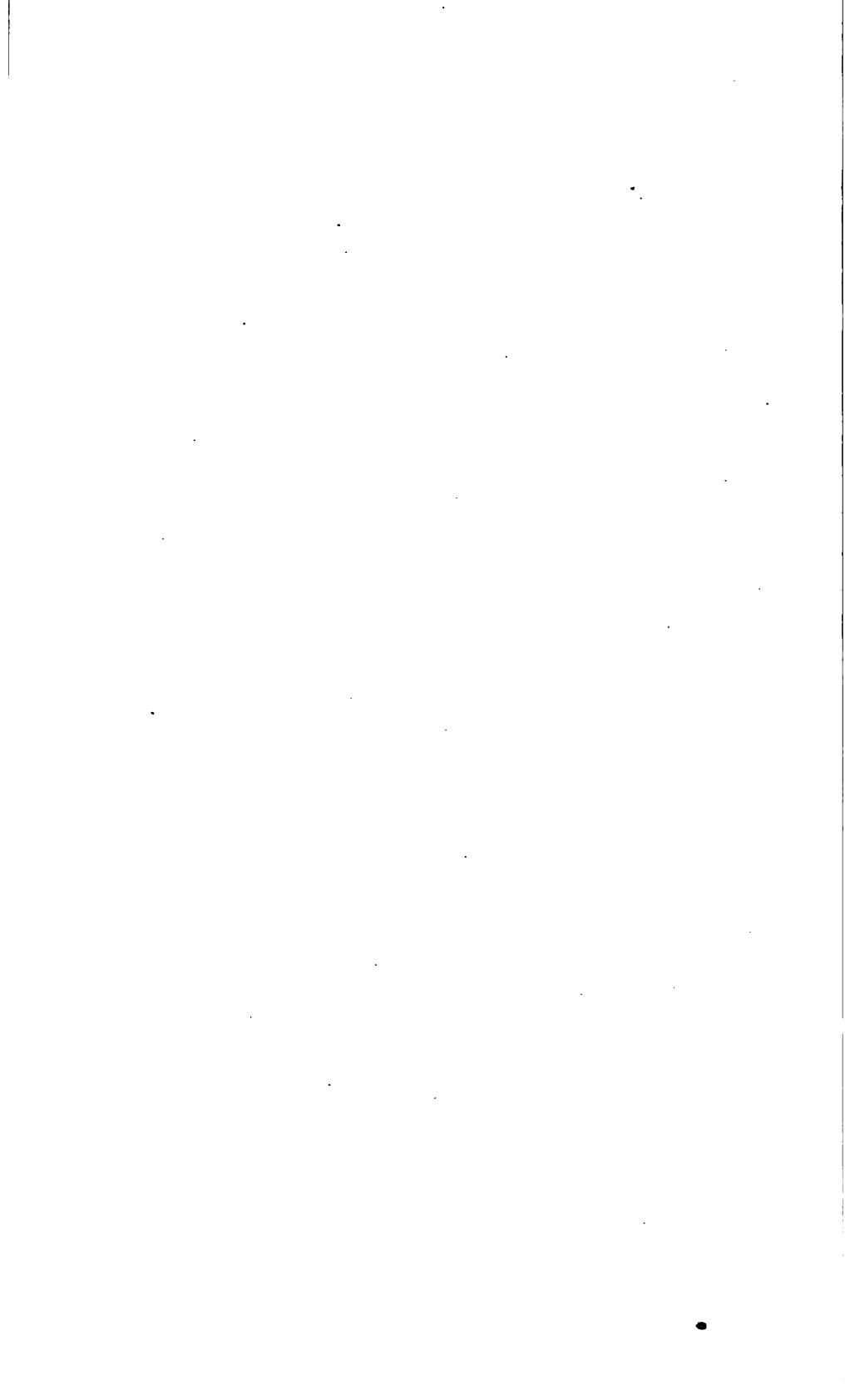


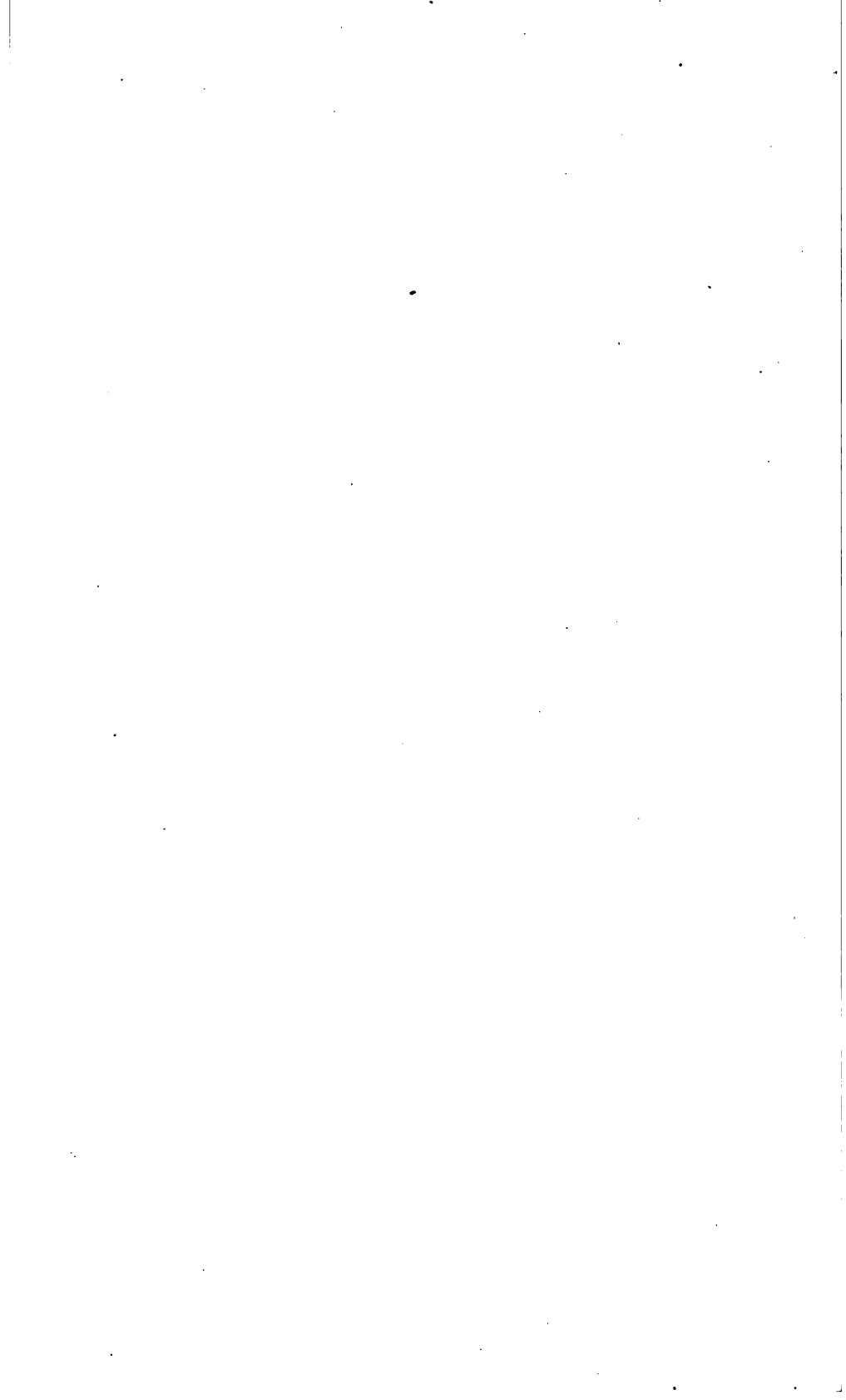


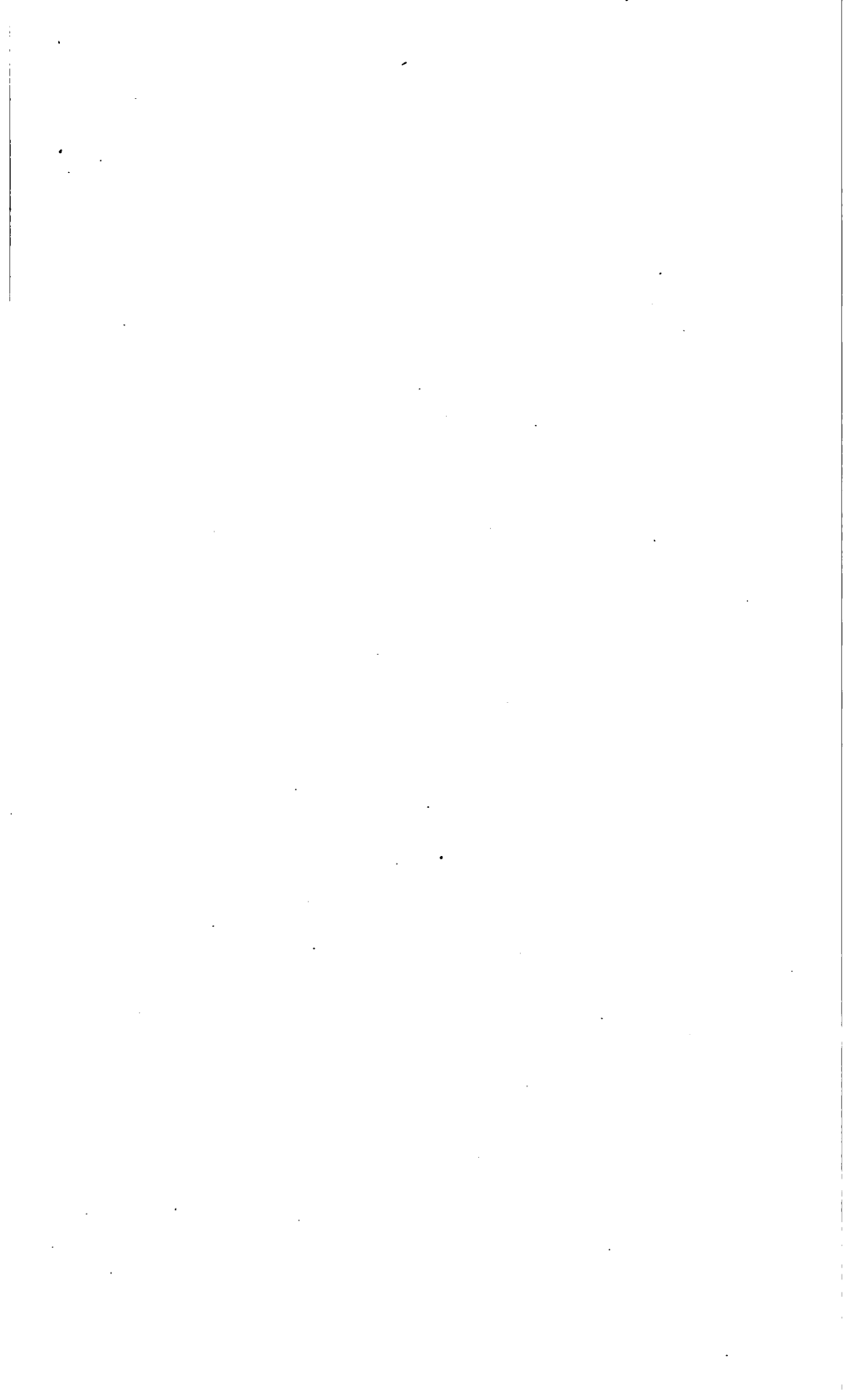


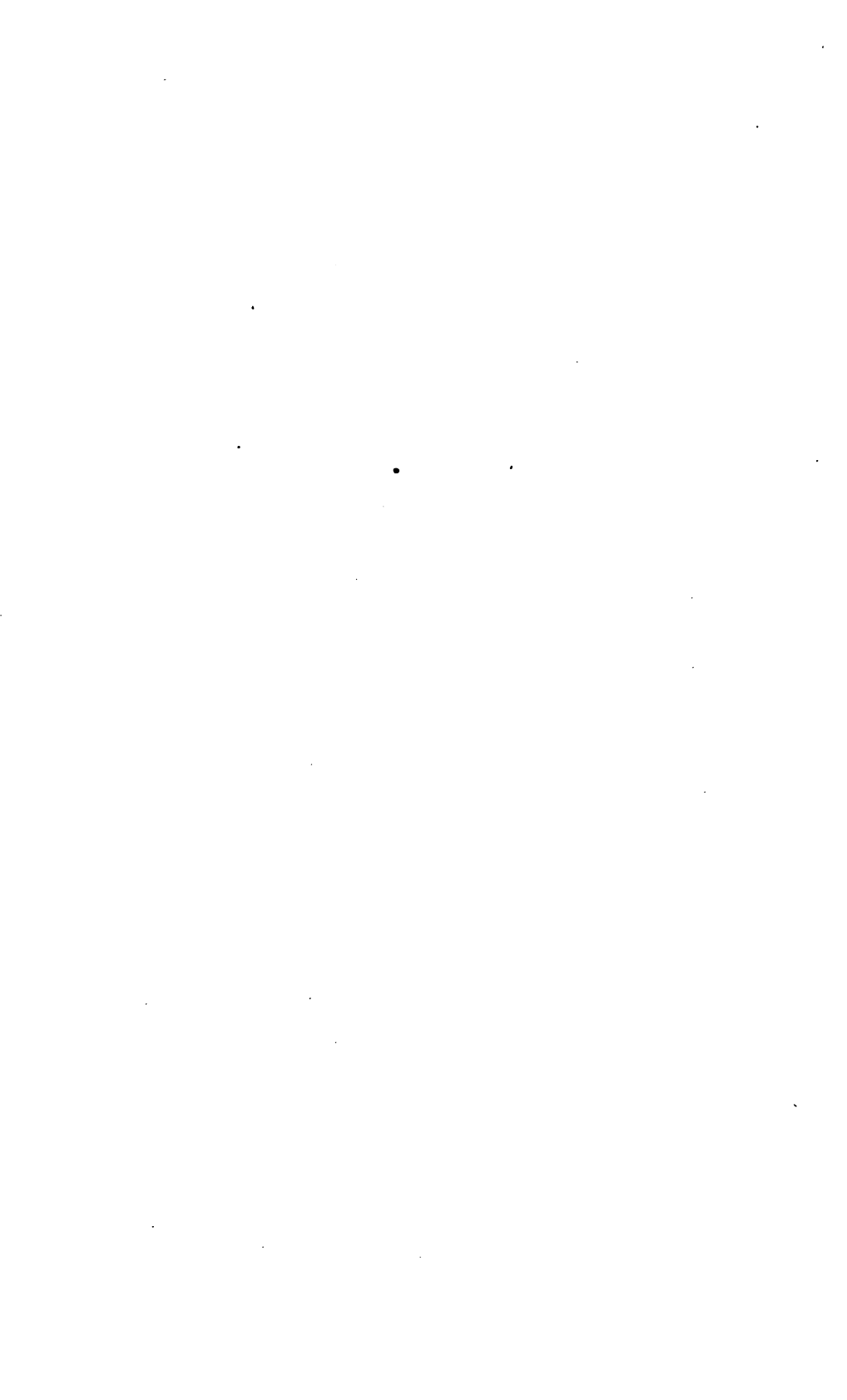


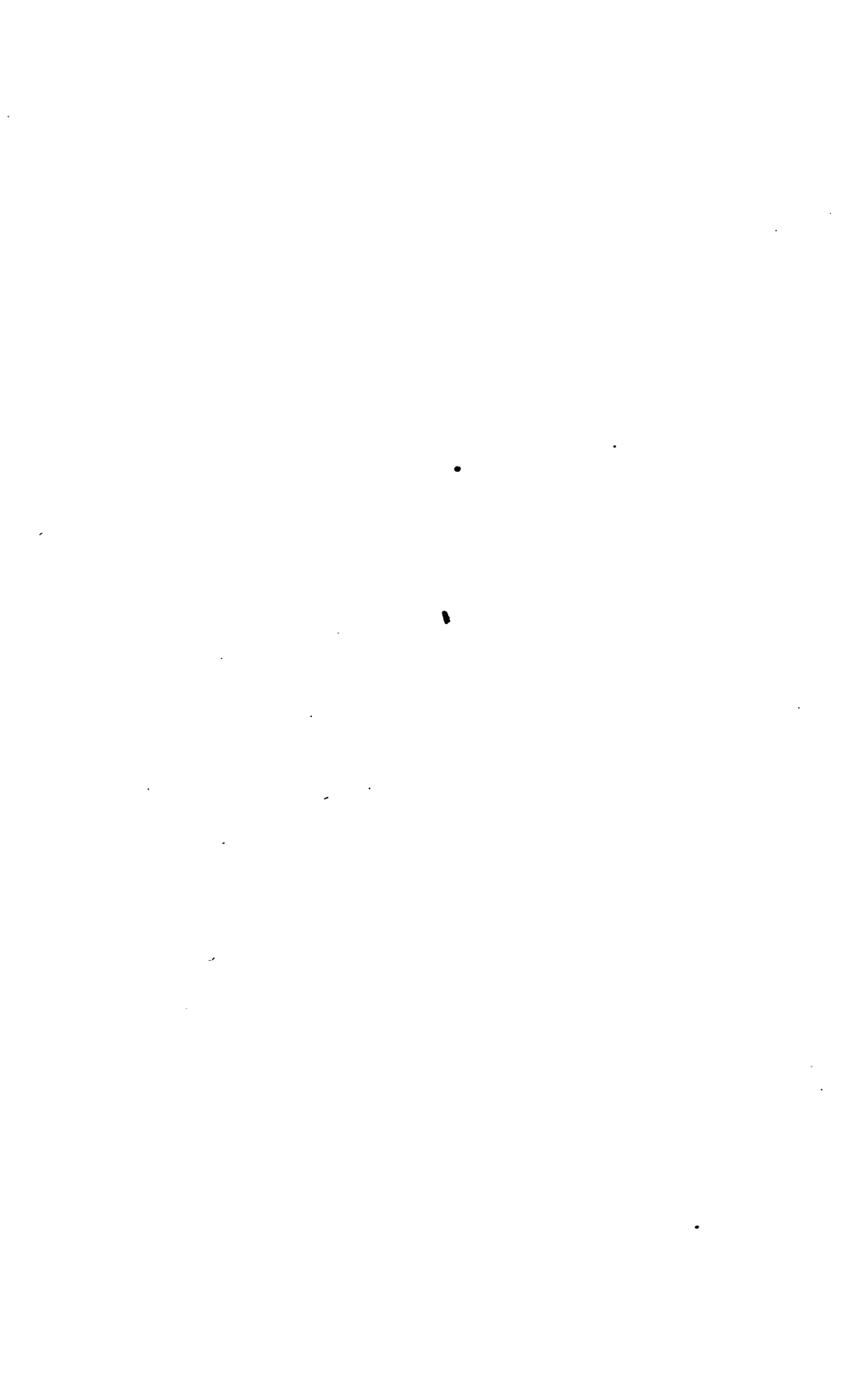




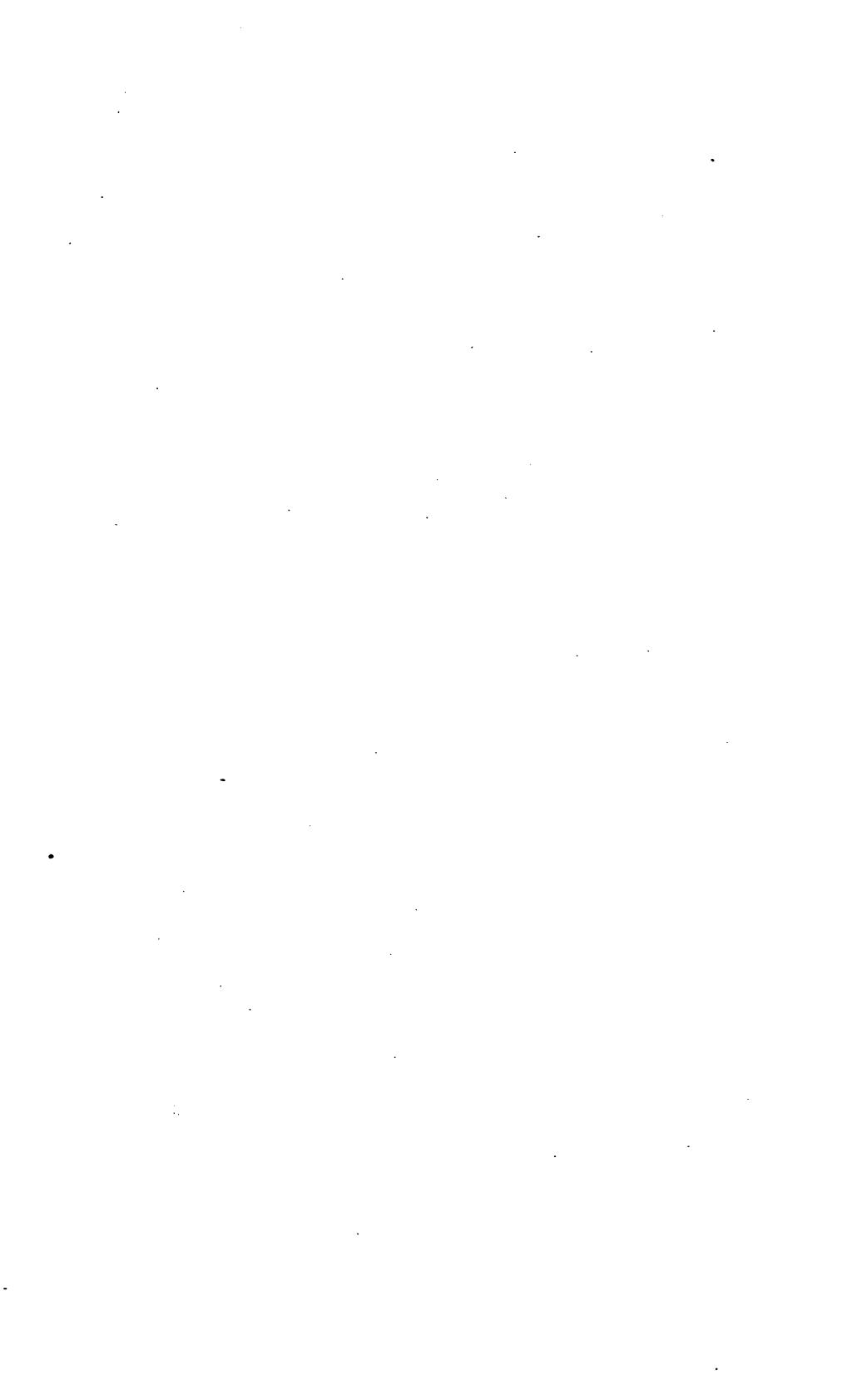


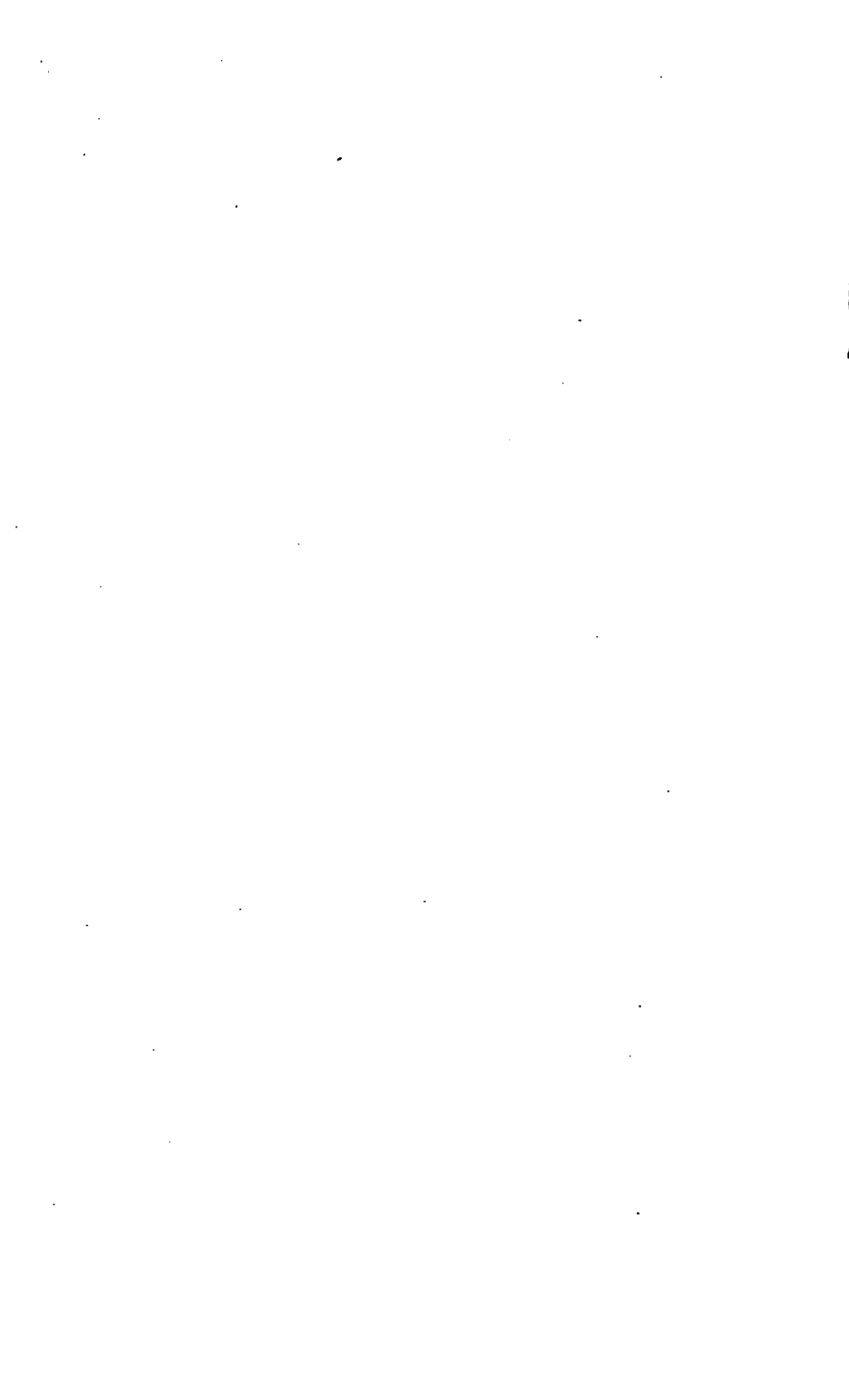




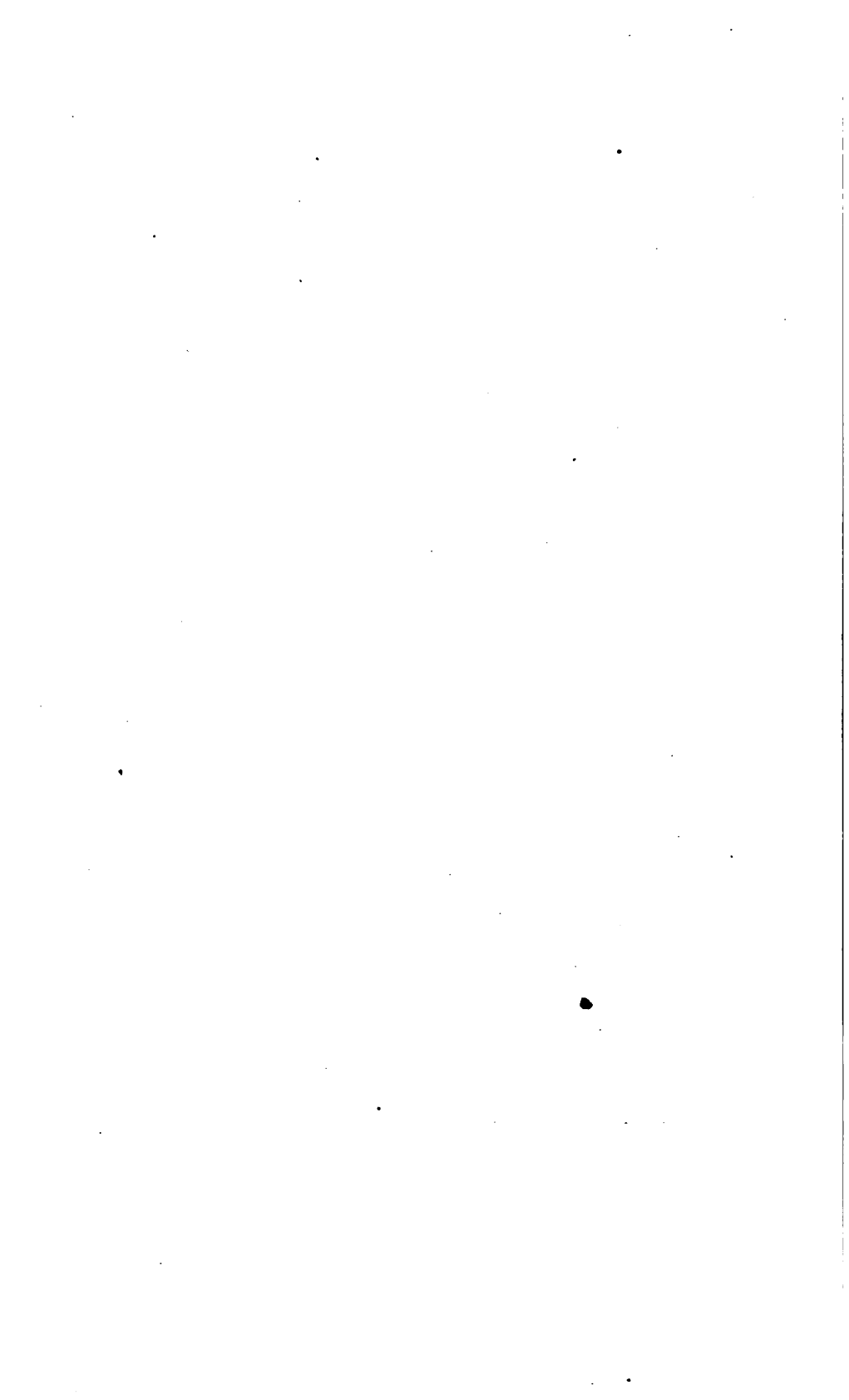


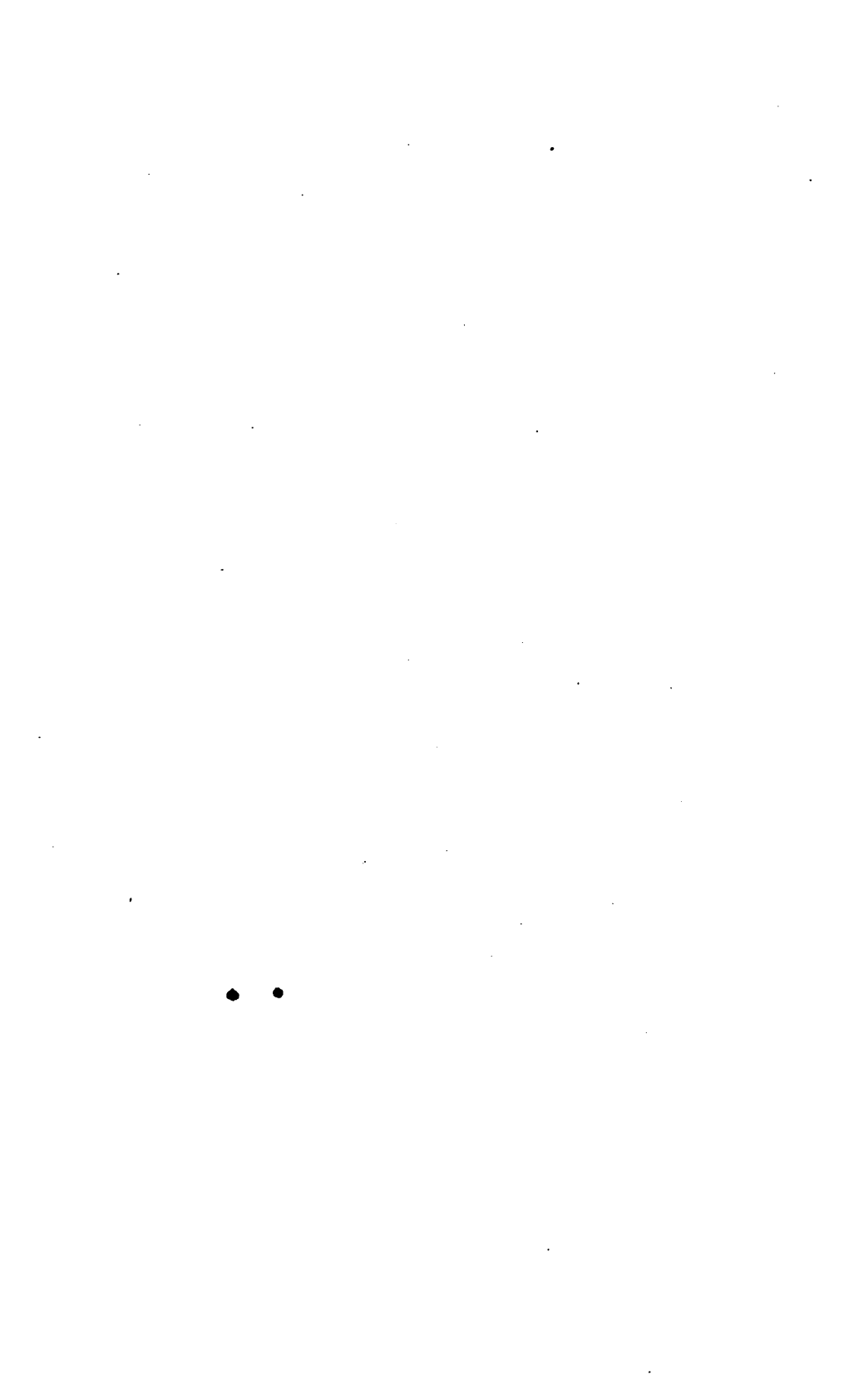
















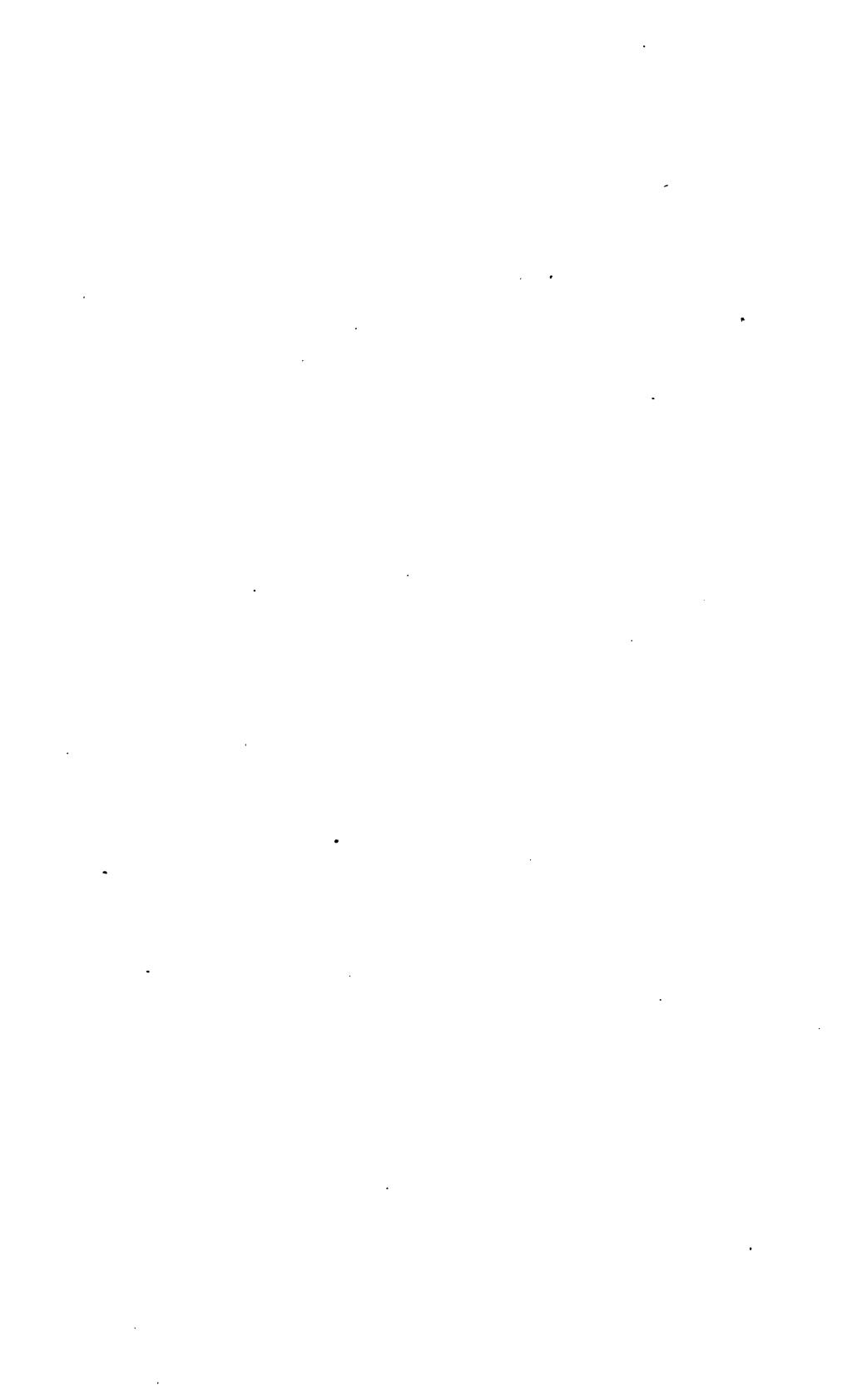


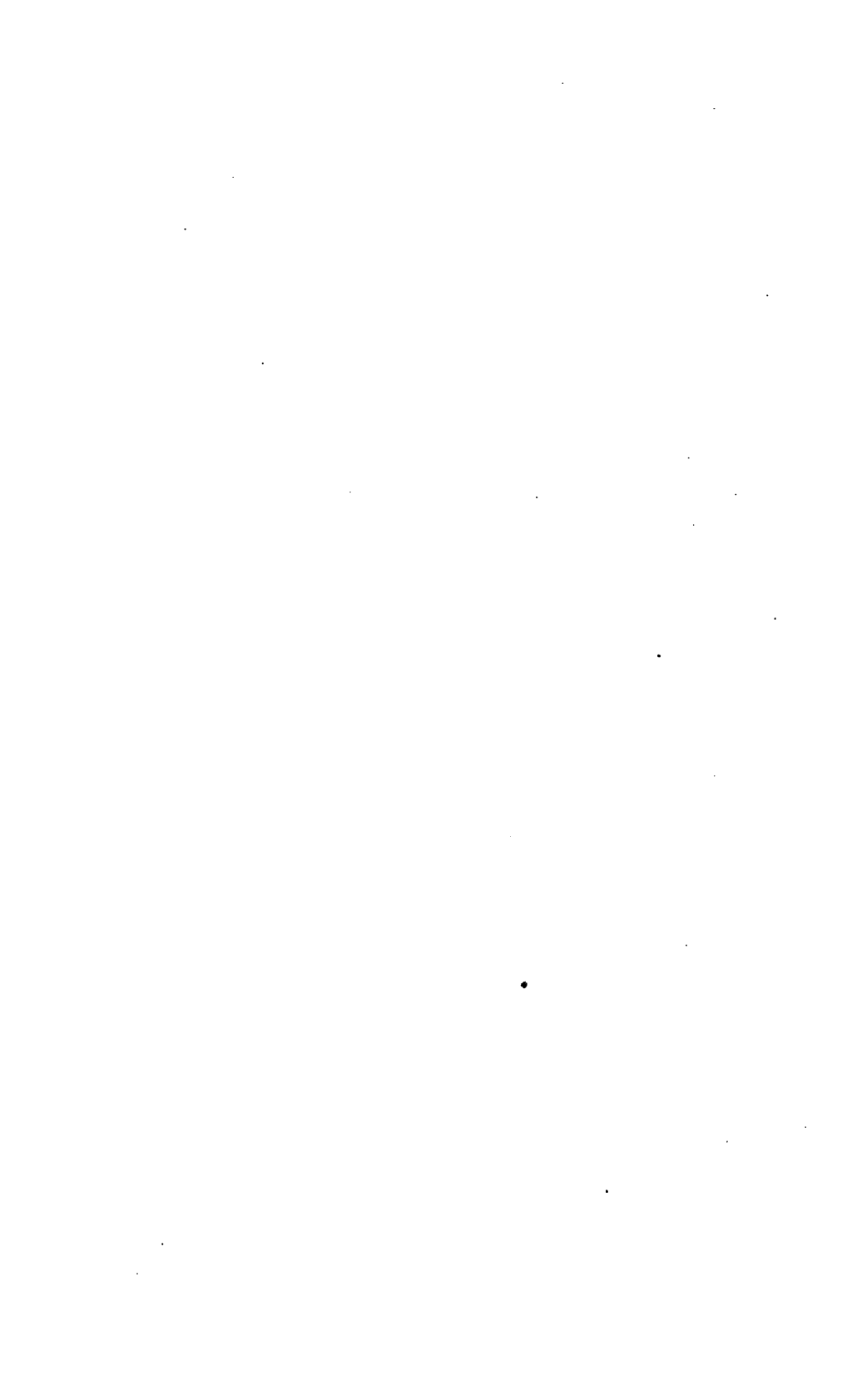


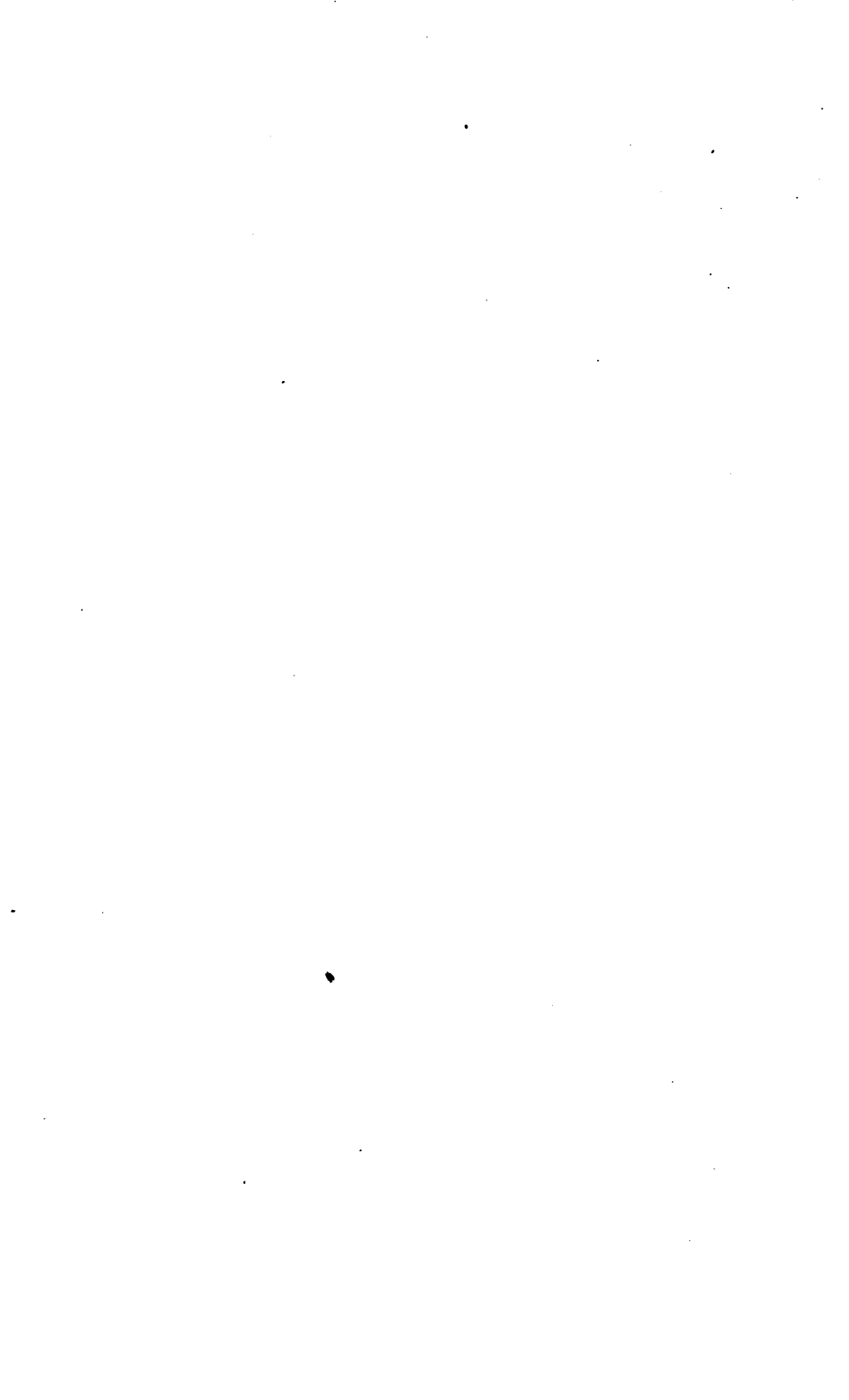






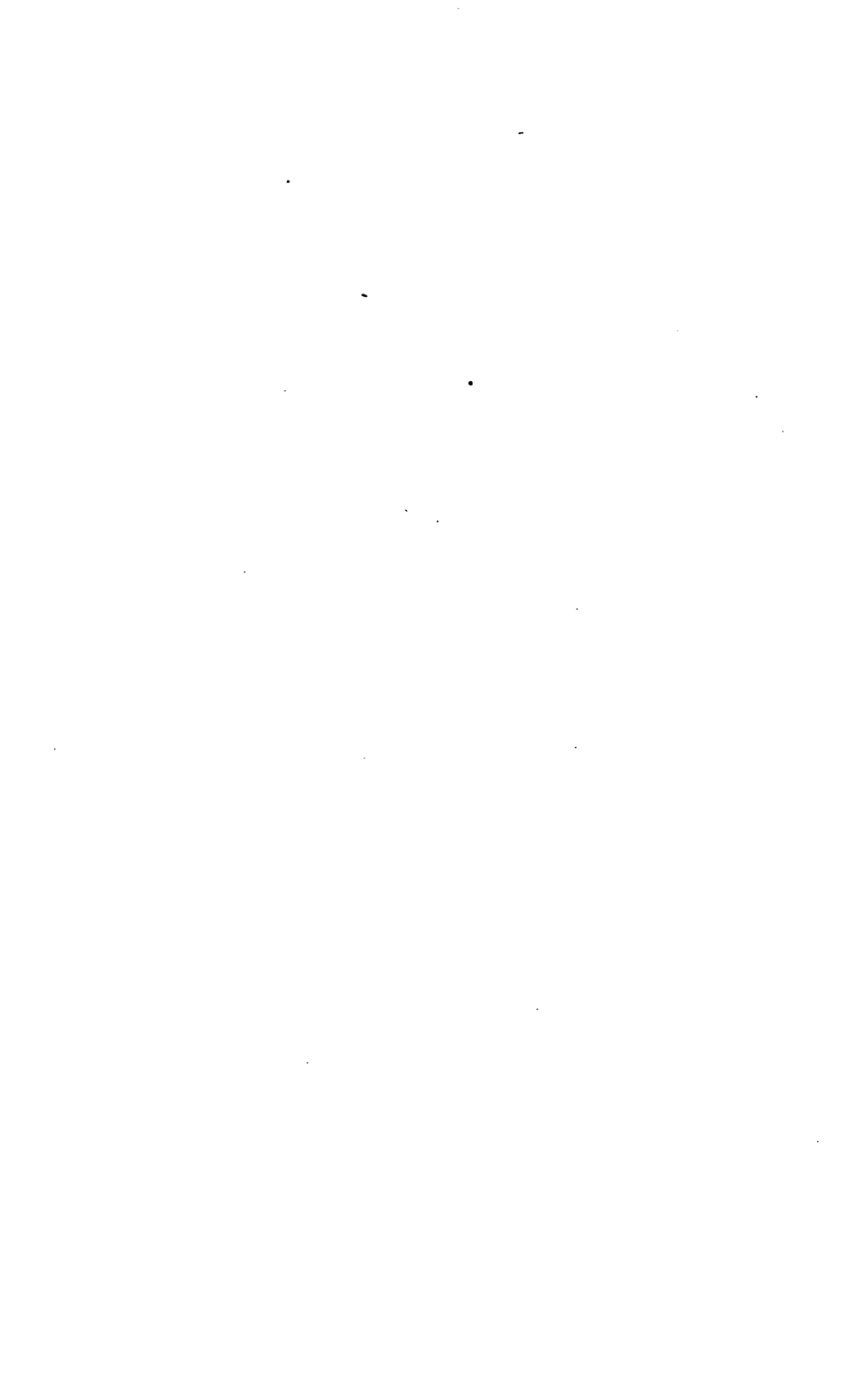




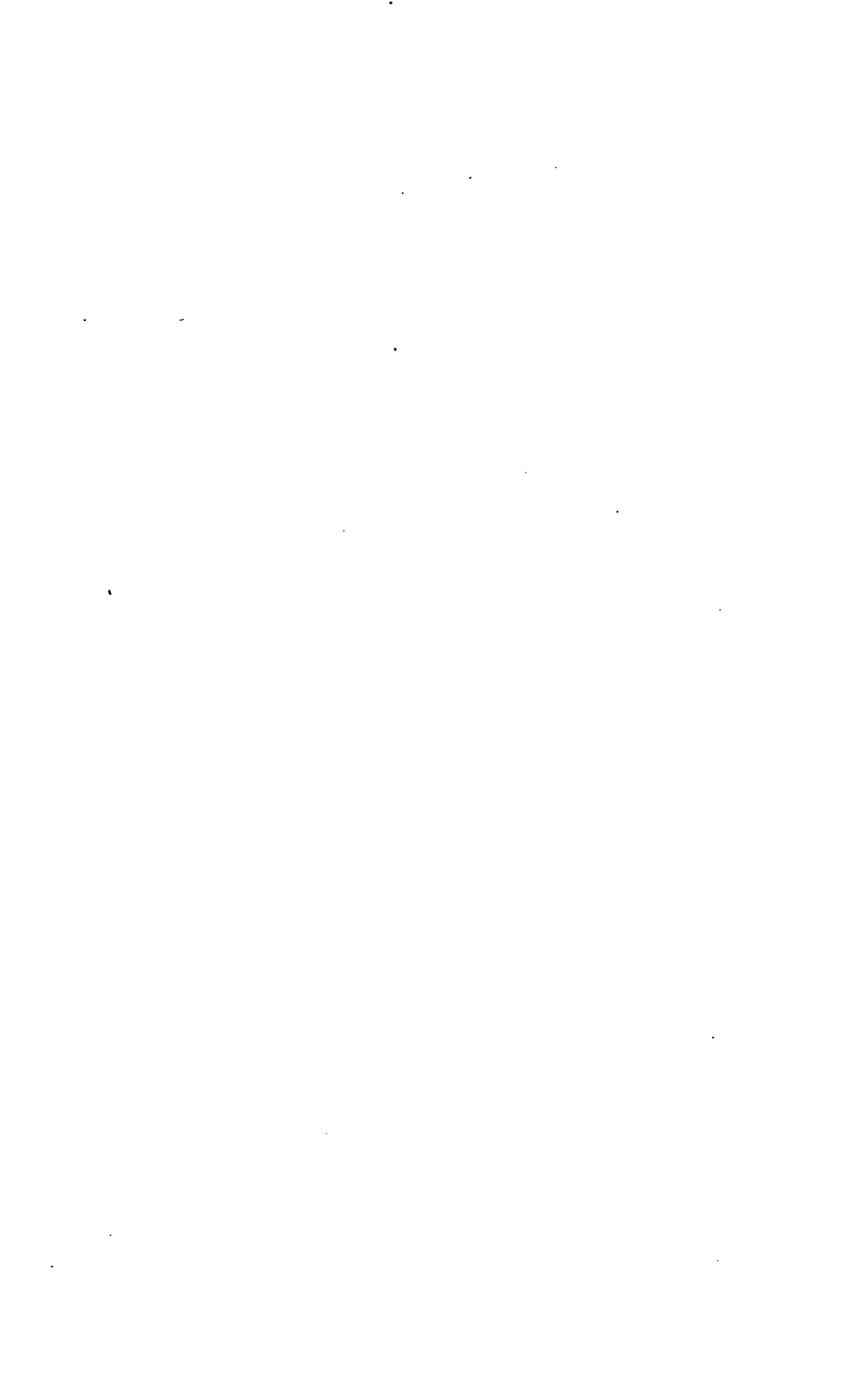










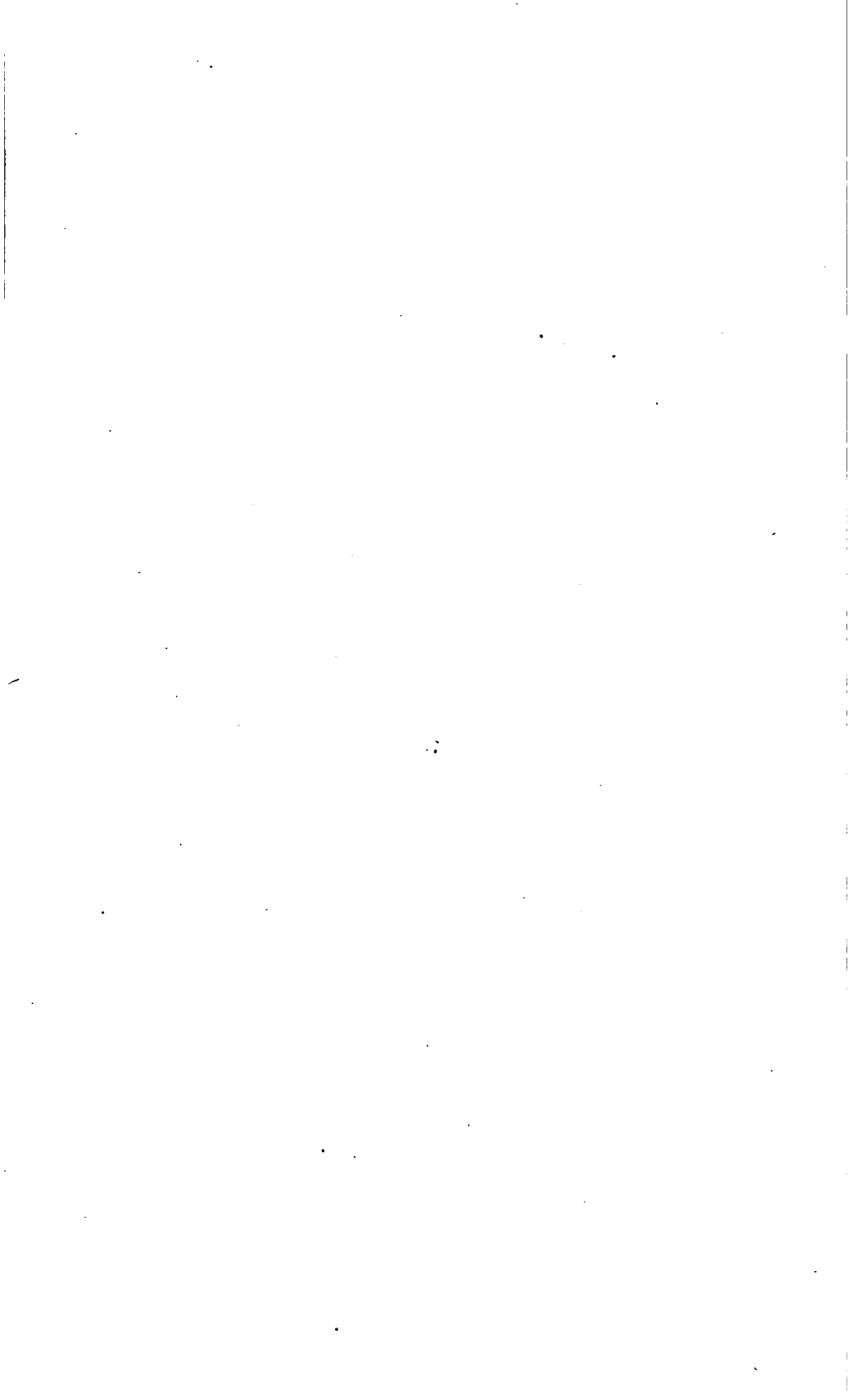




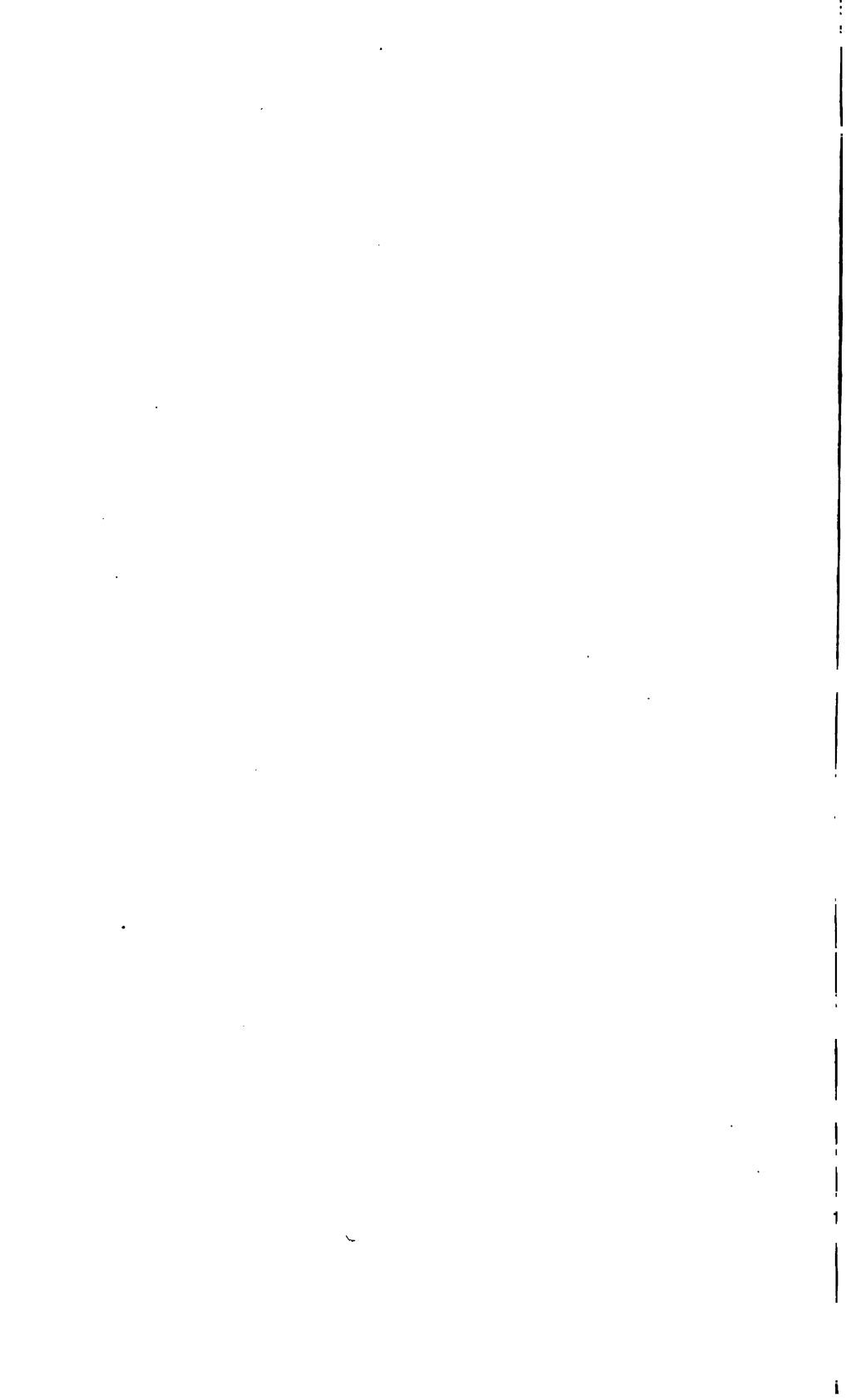


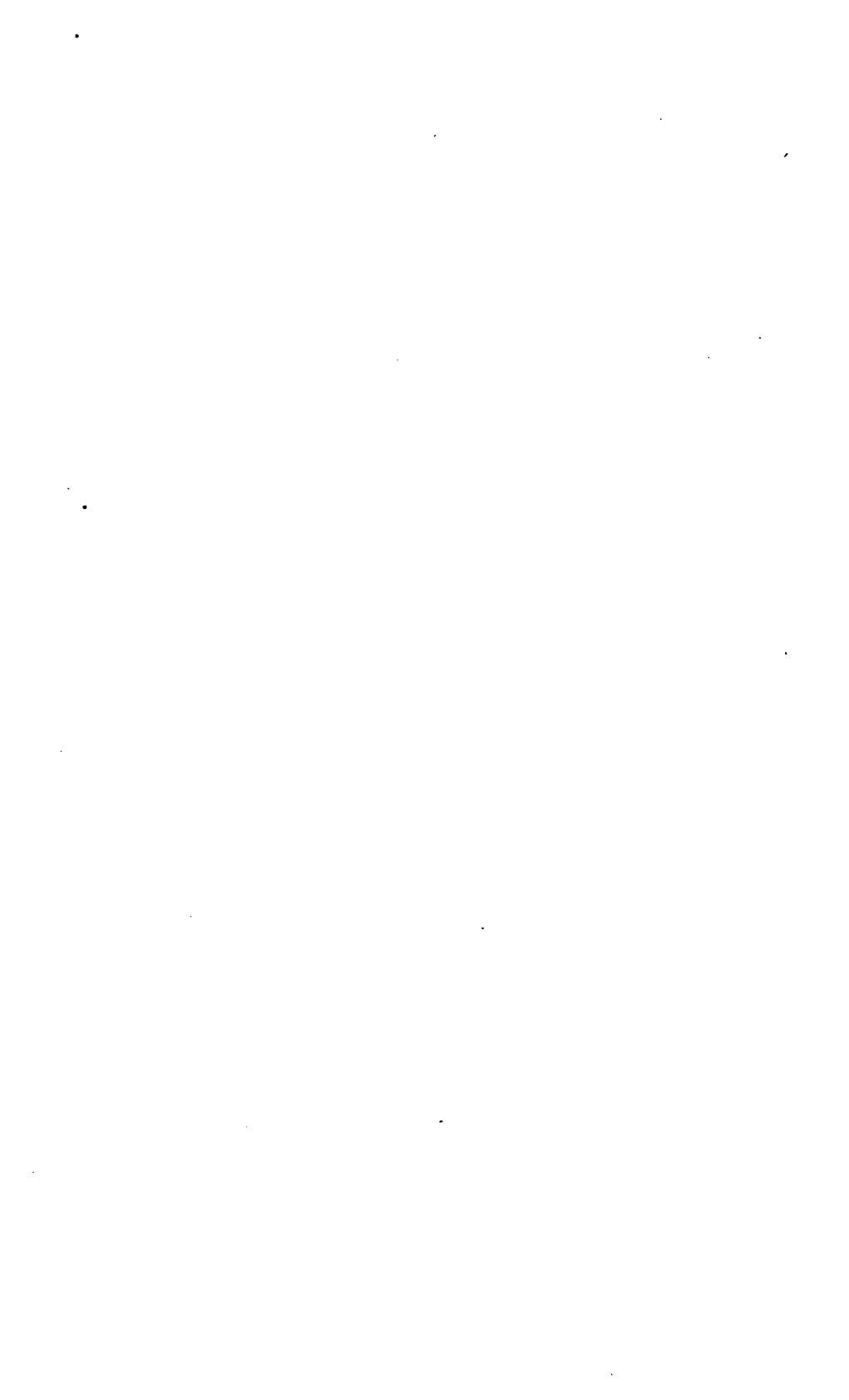


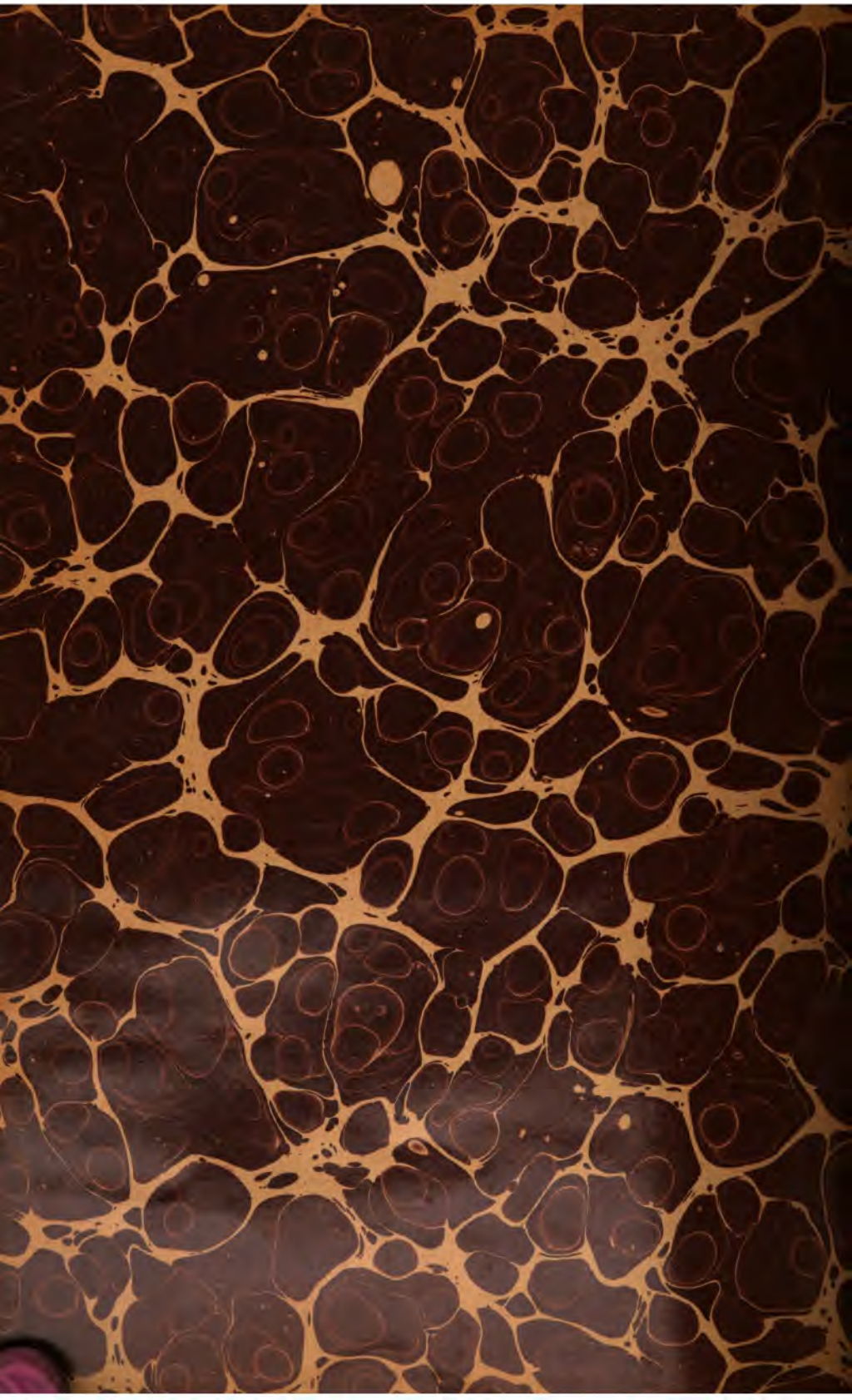


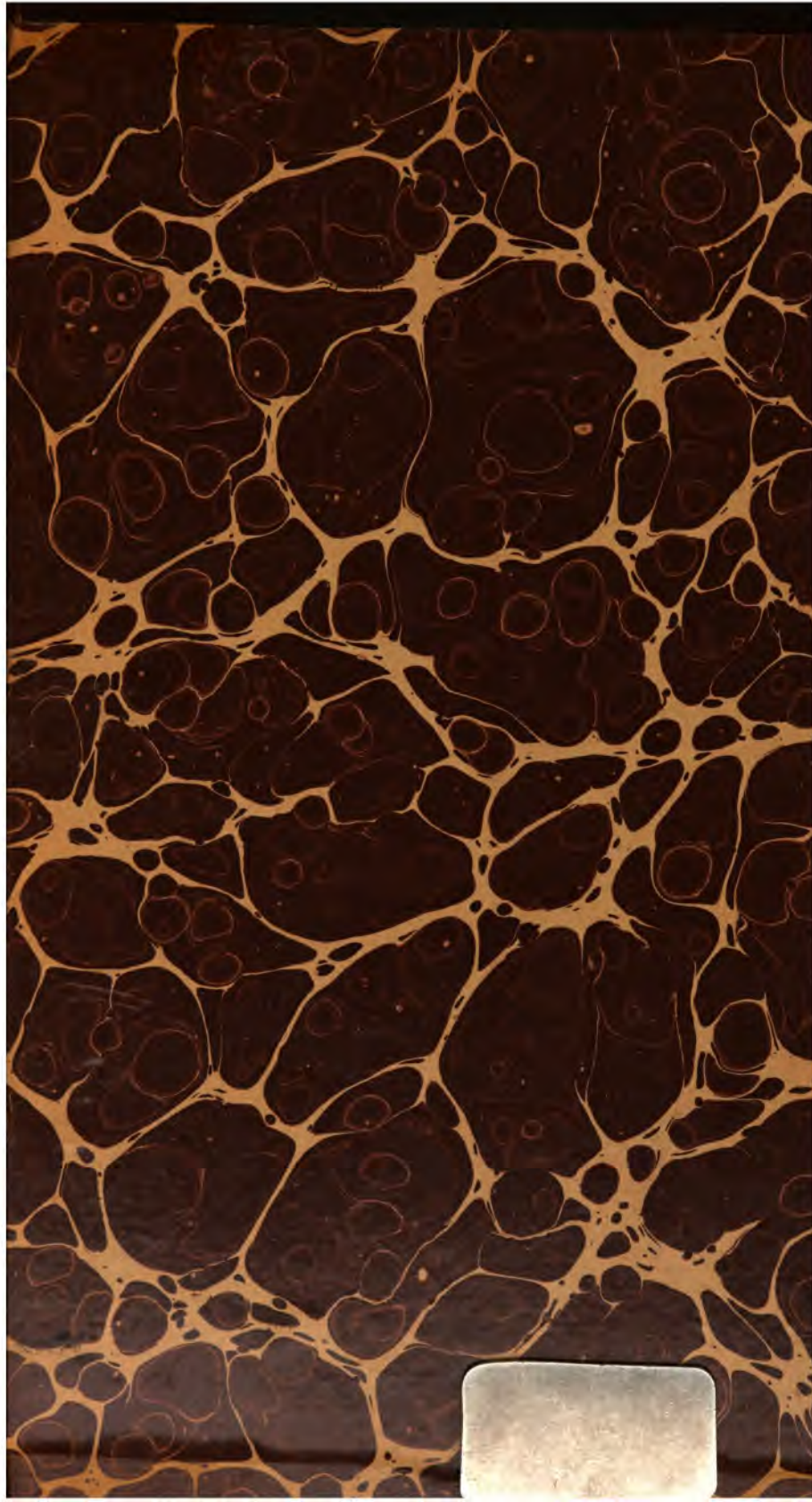












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